MARINE ENGINEERING.

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TWIN SCREW STEAMBOAT "PENNSYLVANIA" BUILT FOR THE CAPE CHARLES ROUTE.

An unusually interesting vessel, the T. S. S. *Pennsylvania,* was recently put into service on the waters of Chesapeake Bay in what is generally known as the Cape Charles Route. This service is maintained by the New York, Philadelphia and Norfolk Railroad Company, which operates its land lines from Cape Charles, Va., to Delmar, Md., where connection is made with the Pennsylvania Railroad system. There are close traffic connections between these companies, through trains being operated between Cape Charles and Philadelphia and New York, making connections at the latter for more distant points. The steamship route connects Cape Charles with Norfolk, Va., touching at Old Point Comfort. The steamboats of the N. Y. P. & N. R. R. Co. carry not only passengers and their baggage, but freight between these points. The service is performed twice a day, and with the present facilities passengers can leave New York at 8.55 p. m. and reach Norfolk in time for breakfast next day, or on returning they can leave Norfolk at 6 p. m. and arrive in New York at 7.32 a. m. next morning. The

TWIN SCREW FAST PASSENGER AND FREIGHT STEAMBOAT PENNSYLVANIA ON "CAPE CHARLES ROUTE."

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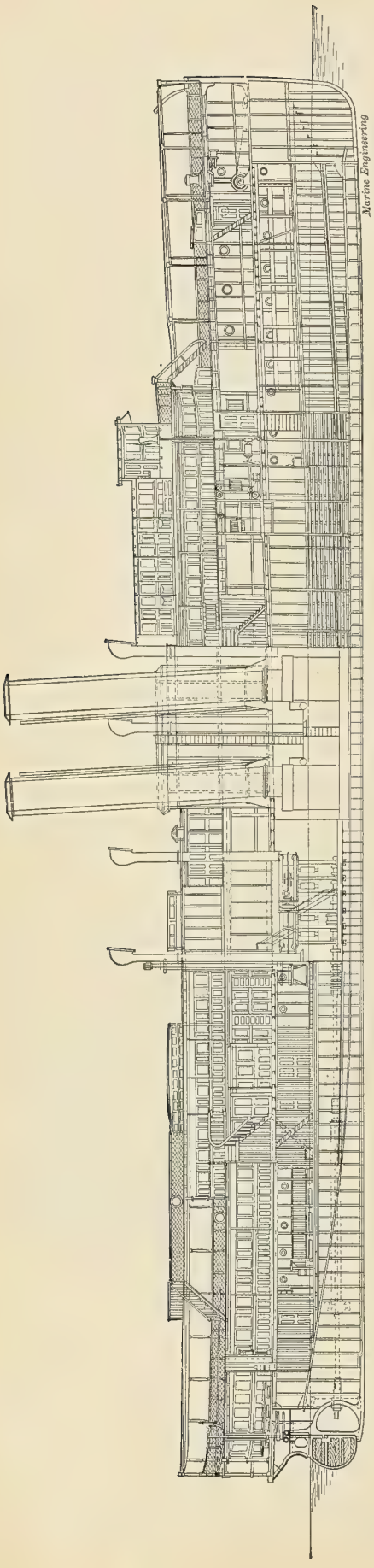
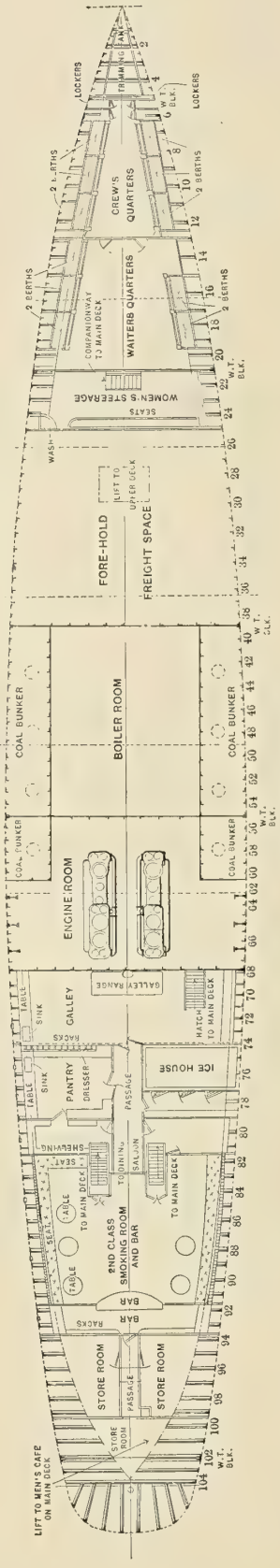
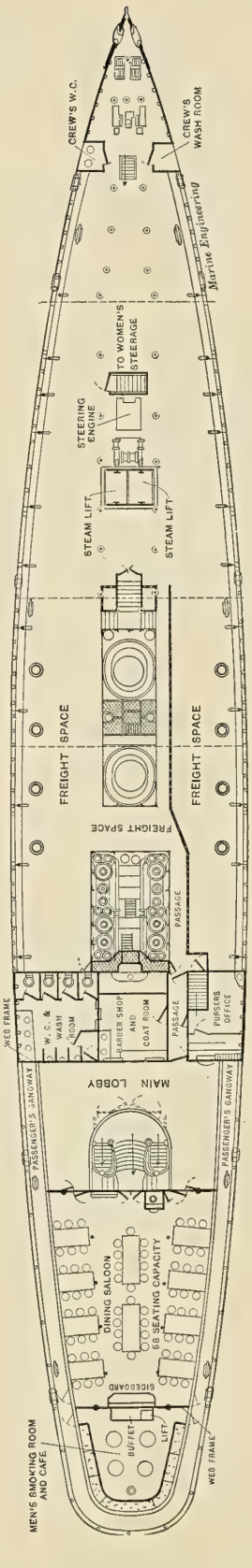


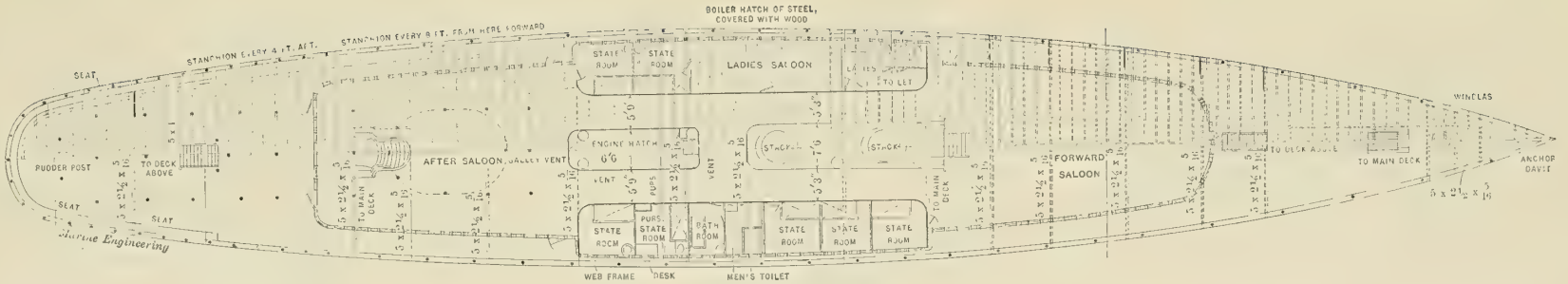
INBOARD PROFILE.



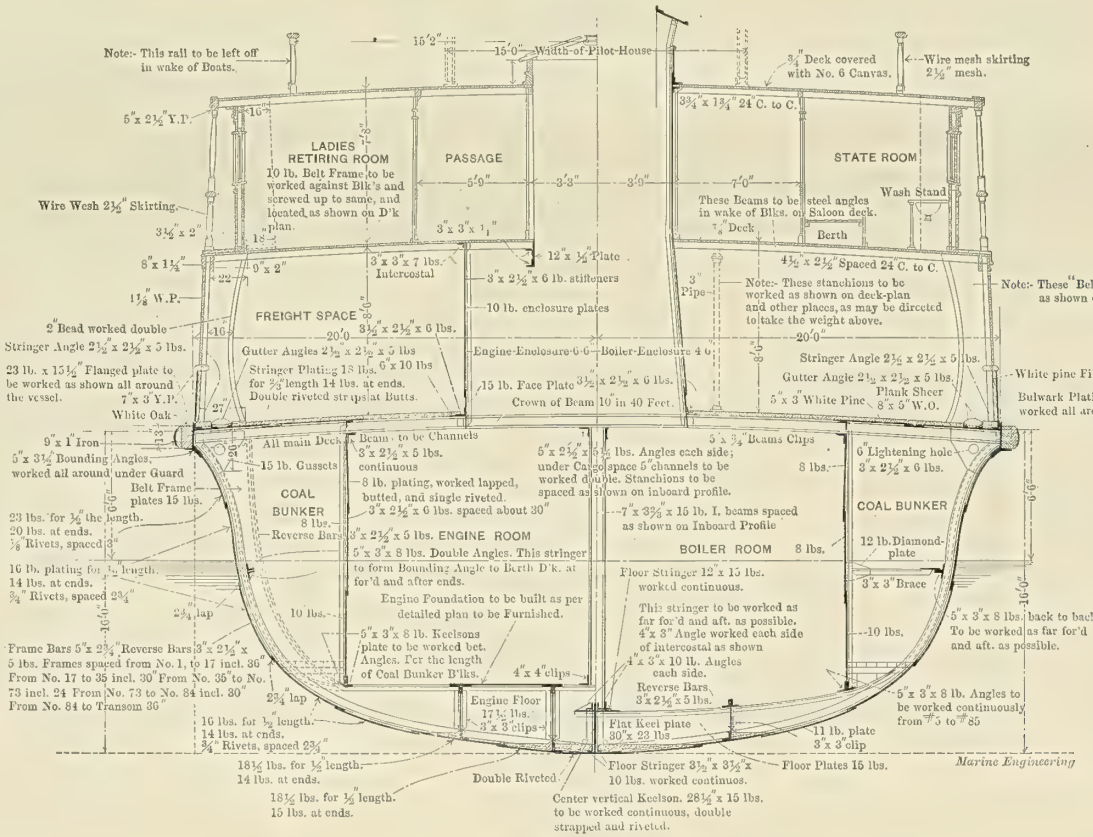
LOWER DECK.



MAIN DECK.



SALOON DECK.


Note:- This rail to be left off in wake of Boats.
15'2"
15'0" Width of Pilot House
¾" Deck covered with No. 6 Canvas.
Wire mesh skirting 2½" mesh.
5"x 2½" Y.P.
3¾" x 1¾" 24" C. to C.
LADIES RETIRING ROOM
10 lb. Belt Frame to be worked against Blk's and screwed up to same, and located as shown on D'k plan.
PASSAGE
STATE ROOM
Wash Stand
Wire Wesh 2½" Skirting
3½" x 2"
8"x 1¼"
11/16" W.P.
2" Bead worked double
Stringer Angle 2½" x 2½" x 5 lbs.
23 lb. x 15½" Flanged plate to be worked as shown all around the vessel.
7"x 3" Y.P.
White Oak
9"x 1" Iron
5"x 3½" Bounding Angles worked all around under Guard
Belt Frame plates 15 lbs.
23 lbs. for ½" the length.
20 lbs. at ends.
⅛" Rivets, spaced 3"
16 lb. plating for ½" length.
14 lbs. at ends.
¾" Rivets, spaced 2¾"
Frame Bars 5"x 2¾" Reverse Bars 3"x 2½" x 5 lbs. Frames spaced from No. 1, to 17 incl. 36" From No. 17 to 35 incl. 30" From No. 35 to No. 73 incl. 24 From No. 73 to No. 84 incl. 30" From No. 84 to Transom 36"
3"x 3"x 1/4"
12"x ½" Plate
3"x 2½"x 6 lb. stiffeners
10 lb. enclosure plates
3" Pipe
These Beams to be steel angles in wake of Blks. on Saloon deck.
7/8" Deck
Berth
4½" x 2½" Spaced 24" C. to C.
Note:- These stanchions to be worked as shown on deck-plan and other places, as may be directed to take the weight above.
Note:- These "Belts" to be spaced as shown on deck-plan.
3"x 3"x 7 lbs. Intercostal
FREIGHT SPACE
20'0"
3½"x 2½" 6 lbs.
Gutter Angles 2½" x 2½" x 5 lbs
Stringer Plating 18 lbs. 6"x 10 lbs for ⅔ length 14 lbs. at ends. Double riveted strips at Butts.
Engine Enclosure 6'6"
Boiler Enclosure 4'6"
15 lb. Face Plate 3½" x 2½" x 6 lbs.
Crown of Beam 10" in 40 Feet.
20'0"
Stringer Angle 2½" x 2½" x 5 lbs.
Gutter Angle 2½" x 2½" x 5 lbs.
Plank Sheer 5"x 3" White Pine
8"x 5" W.O.
White pine Filling
Bulwark Plating 5 lbs. worked all around vessel.
All main Deck
15 lb. Gussets
COAL BUNKER 8 lbs.
Reverse Bars
Beam to be Channels 3"x 2½" x 5 lbs. continuous
8 lb. plating, worked lapped, butted, and single riveted.
3"x 2½" x 6 lbs. spaced about 30"
3"x 2½" x 5 lbs. ENGINE ROOM
5"x 3"x 8 lbs. Double Angles. This stringer to form Bounding Angle to Berth D'k. at for'd and after ends.
Engine Foundation to be built as per detailed plan to be Furnished.
5"x 3"x 8 lb. Keelsons plate to be worked bet. Angles. For the length of Coal Bunker B'lks.
4"x 4" clips
Engine Floor 17½ lbs.
3"x 3" clips
5"x 2½" x 6½ lbs. Angles each side; under Cargo space 5" channels to be worked double. Stanchions to be spaced as shown on inboard profile.
5 x ¾" Beams Clips
8 lbs.
7"x 3⅝" x 15 lb. I. beams spaced as shown on Inboard Profile
BOILER ROOM 8 lbs.
Floor Stringer 12"x 15 lbs. worked continuous.
This stringer to be worked as far for'd and aft. as possible.
4"x 3" Angle worked each side of intercostal as shown
4"x 3"x 10 lb. Angles each side.
Reverse Bars 3"x 2½"x 5 lbs.
Flat Keel plate 30"x 23 lbs.
6" Lightening hole
3"x 2½" x 6 lbs.
COAL BUNKER
12 lb. Diamond plate
3"x 3" Brace
5"x 3"x 8 lbs. back to back. To be worked as far for'd and aft. as possible.
5"x 3"x 8 lbs. Angles to be worked continuously from #5 to #85
11 lb. plate
3"x 3" clip
Floor Plates 15 lbs.
Marine Engineering
2¾" lap
10 lbs.
16 lbs. for ½ length.
14 lbs. at ends.
¾" Rivets, spaced 2¾"
18½ lbs. for ½ length.
14 lbs. at ends.
18½ lbs. for ½" length.
15 lbs. at ends.
Double Riveted
Floor Stringer 8½" x 3½" x 10 lbs. worked continuous.
Center vertical Keelson. 28½" x 15 lbs. to be worked continuous, double strapped and riveted.

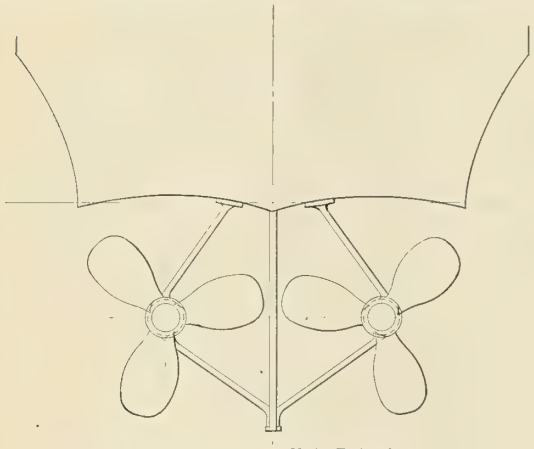
CROSS SECTIONS.

PLANS OF THE T. S. S. PENNSYLVANIA FOR N. Y. P. & N. R. R. CO. DRAWN BY GARDNER & COX, NEW YORK. VESSEL BUILT AT ROACH YARD, CHESTER, PA.

average number of passengers handled on the Cape Charles route is about 150 and the weight of baggage 20,000 lb. In addition a large quantity of high class freight is handled, especially northbound perishable stuff, the average being about 4,000 barrels, consigned to New York and Philadelphia merchants, each trip. The freight capacity of the *Pennsylvania* is about 300 tons.

The distance from Cape Charles to Norfolk, Va., is about thirty-five miles, and the run is made by the *Pennsylvania* on a schedule of two hours and fifteen minutes, in which is included a stop at Old Point Comfort of about twenty minutes. This run does not indicate the actual speed of the boat, for the reason that there are speed restrictions for a considerable distance in Norfolk Harbor, and again there is shallow water on the eastern side of the bay, where it is not possible to attain full speed. The maximum service speed of the *Pennsylvania* is about 18 knots. The service is continued throughout the entire year.

As shown in our frontispiece, the new steamer is a handsome, shipshape, vessel, with the usual American steamboat superstructure, two well proportioned funnels and a pleasing amount of sheer. Her chief point of peculiarity, or difference from other vessels engaged in similar service, is that she has a modified torpedo boat or knuckle stern. This is not so readily distinguishable in the photograph as in the small stern view in outline on this page. The stern of the *Pennsylvania* differs from the regular torpedo boat stern in that it has practically two sterns divided at the knuckle in the same style as the English channel steamer *Tamise,* of 1,000 tons. The *Pennsylvania* was designed by Naval Architects Gardner & Cox, of New York, and built at the Roach yard, Chester, Pa.



STERN OF T. S. S. PENNSYLVANIA.

Her principal dimensions are: Length over all, 260 ft.; between perpendiculars, 247 ft.; beam moulded, 37 ft. 8 in.; beam over guards, 40 ft. 9 in.; depth molded at center, 15 ft.; depth molded at side, 14 ft.; depth of hold, 13 ft.; draft, 9 ft. 6 in.; displacement about 1,100 tons.

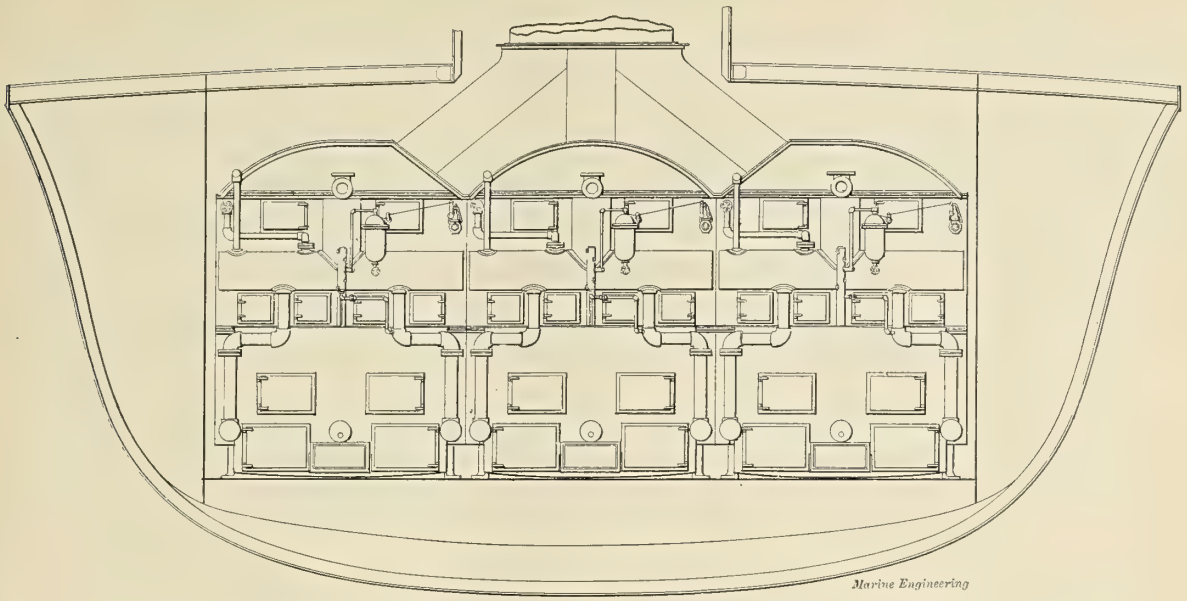
The steel hull of the vessel is heavy and rigid, and the scantlings are equal or in excess of the requirements of the U. S. Standard Association. The frames are of 5 in. bulb angles, spaced 36 in. apart from Nos. 1 to 17, and from No. 84 to transom; 30 in. apart from Nos. 17 to 35 and from Nos. 73 to 84; and 24 in. apart from Nos. 35 to 73. Reverse frames are 3 in. by 2 1-2 in. by 5 lb., angle bars extending to the upper turn of the bilge. Floor plates are 24 in. deep, of 15 lb. plate, and 17 1-2 lb. in the engine space. The vertical keel is 28 1-2 in. by 15 lb., and extends from the flat keel to 5 in. above the top of the floors. It is secured to the keel plate by double 3 1-2 in. by 3 1-2 in. by 10 lb. angles, and at its upper edge by 4 in. by 3 in. by 10 lb. angles. The flat keel plate is 30 in. by 23 lb. A side keelson formed of intercostal plates, with double continuous 4 in. by 3 in. angle bars is worked amidship and as far forward and aft as practicable. The bilge keelsons consist of two 5 in. by 3 in. by 8 lb. angles, riveted back to back. In the machinery space the wing bulkheads are placed on the line of this keelson. A side keelson is formed of 5 in. by 3 in. by 8 lb. angles riveted back to back and extending practically the entire length. The main deck beams are channel section 7 in. by 2.01 in. by 12 lb., and reduced to 6 in. by 1.9 in. by 9.5 lb. at the ends. They are located in every alternate frame.

On the accompanying cross section the arrangement of guards and stringer plates is clearly indicated. The shell is plated with in and out strakes, with 7 strakes on each side, not including the flat keel. For the sheer strake 23 lb. plate is used for half the length and 20 lb. at the ends. The rivets are 7-8 in., spaced 3 in. apart, and the lap is 2 3-4 in. Side and bilge plating is 16 lb. for half the length, reduced to 14 lb. at the ends, with 3-4 in. rivets spaced 2 3-4 in. Bottom plates are 18 1-2 lb. for half length and 14 and 15 lb. at the ends Deck stanchions of 7 in. by 3 2-3 in. by 15 lb. I-beams are worked in the center line of the vessel about 8 ft. apart. The main deck stringers are of 18 lb. for two-thirds of the length and 14 lb. at the ends, with double riveted straps at the butts. White pine planking is used for the main deck, 5 in. by 3 in. Above the guard the bulwark plating is 5 lb. worked all around the vessel, and filled with 1 3-8 in. white pine up to the main rail, and from this up to the saloon deck the sides are of 1 1-8 in. white pine. The saloon deck is 8 ft. 6 in. above the main deck, and is constructed of 7-8 in. tongued and grooved stock, laid on 4 1-2 in. by 2 1-2 in. wood carlines spaced 24 in. centers.

Above the saloon deck, 7 ft. 8 in., is the upper promenade deck, of 3-4 in. matched boards, covered with No. 6 canvas and painted with French yellow. This deck is laid on carline 3 3-4 in. by 1 3-4 in., 24 in. centers. The saloon deck extends the whole length of the vessel; but the house, which is 150 ft. long, extends close to the sides, so on this deck the outside passenger deck space is quite limited, and occupants of the interior rooms can enjoy a considerable degree of privacy.

The promenade deck commences about 45 ft. abaft the stem and runs to the stern, but passengers are excluded from the after 38 ft. of this deck. At the two ends of the vessel a lower deck is worked.

Commencing on this deck, at the forward end, aft of the collision bulkhead, is the chain locker, which extends from the keel to the main deck. Next comes a room about 23 ft. long, with berths and lockers, for the accommodation of the dozen sailors or deck hands. Aft of this room is another compartment about 21 ft. 6 in. long, similarly fitted with ten berths and used as



CROSS SECTION OF FIRE ROOM, T. S. S. PENNSYLVANIA, SHOWING ALMY WATER TUBE BOILERS IN POSITION.

the waiters' quarters. Next to the after bulkhead of the waiters' quarters comes the women's steerage about 10 ft. in a fore and aft direction and extending the width of the vessel. This is reached by a staircase leading down from an enclosure on the main deck just forward of the steering engine room. The next 33 ft., from the women's steerage to the boiler room bulkhead, is occupied by the fore hold, from which freight is handled by a steam lift at the main deck hatches. The next 31 ft. is occupied by the boiler room which measures 25 ft. athwartships. The wing coal bunkers are worked 42 ft. long and extend from

INSTANTANEOUS PHOTOGRAPH OF T. S. S. PENNSYLVANIA GOING AT A HIGH RATE OF SPEED.

the forward boiler room bulkhead into the engine room on both the port and starboard sides. The boilers being of the Almy water tube type fit together very compactly as shown in the cross section of the vessel, through the stoke hold on page 277. The engine room is about 25 ft. in length. Abaft of the engine room comes the galley 12 ft. in a fore and aft direction and the width of the ship. Aft of the galleys, pantries, store rooms and refrigerators, and the stairways to the main saloon, occupy about 21 ft. of the length of the vessel. Next aft comes the second class smoking room and bar occupying about 28 ft. in a fore and aft direction. This is comfortably fitted with upholstered seats and six tables, and is, of course, unusually spacious, owing to the form of stern of the vessel. Wine lockers and store rooms utilize all of the vailable space left of this room, including the lazarette.

On the main deck the forward 150 ft. is used as space for freight and baggage, the engine and boiler trunks forming the only considerable obstructions for a clear freight space. On the starboard side of these inclosures a partition is worked, as shown on the plan, giving a clear passageway fore and aft between the passenger and crew spaces on this deck at all times. Aft of the engine hatch the purser's office and ticket office is located, on the starboard side the barber shop and coat room amidships, and large passengers' lavatory on the port side. Next aft is the main lobby or social hall, which is 22 ft. long and about 31 ft. wide, and in which the ornamental staircases lead up to the saloon deck and below to the lower deck. Directly aft of the social hall is the main dining saloon, with 10 tables and capacity for 68 passengers at one sitting. This is a very fine, well shaped and splendidly lighted room, 36 ft. long and about 27 ft. average width. In the after end of the room a handsome sideboard is fitted. In the after end of the house on this deck there is a smoking room and café for the cabin passengers, with upholstered seats along three sides and circular floor tables. All around the house on this deck there is a passageway inside of the rail, and as the sides are not carried above the main deck, an unbroken view on each side and astern can be had.

On the saloon deck the forward saloon occupies about 46 ft. of the house, and is 27 ft. wide. The front is rounded and fitted with doors, so that the passengers can step inside and yet be sheltered by the awnings. Amidships the machinery casings occupy the center of the ship, with a passage on each side fore and aft. Along the starboard side there are six staterooms, and men's toilet room, and on the port side two staterooms, ladies' saloon with twelve reclining chairs, and ladies' toilet room. The aft deck saloon is 43 ft. long and 28 ft. wide. All the furnishings, upholstery, and fittings, are of the usual American steamboat style, the color scheme being white and gold.

On the promenade deck, forward the house, is 40 ft. long and 15 ft. wide. The forward end is occupied by the pilot house, with rounded front and glazed lifting sashes all around. Next comes the captain's room and six large staterooms for the chief engineer, first and second assistant engineers, two mates, mail clerk, oilers and purser. The remainder of the deck is broken only by the boiler room gratings, the engine hatches, ventilators, and the dome over the after saloon. The smoke pipes are elliptical in section, measuring about 8 ft. fore and aft by 5 ft. athwartships, and rising about 26 ft. above the deck.

Boats carried include four 24 ft. metallic life boats, and there is the usual supply of life rafts and life preservers. On each side of the vessel there are three large freight ports about 8 ft. square, between the main and saloon decks, and the passengers' gangways are located opposite the main lobby on the main deck.

Propelling engines of the *Pennsylvania* driving the twin screws are of the vertical four cylinder, triple expansion type, with cylinders 18 in., 29 in., and (2) 33 in dia. and 26 in. stroke. All the main valves are of the piston type worked by Stephenson gear with double bar links. The framing for each engine consists of six pairs of cast steel columns well stiffened by diagonal ties. Cast iron is used for the bed plates, which are carried by wrought steel keelson plates forming the foundation. Each crank shaft is in two sections, and all shafting, piston, and connecting rods and working parts of the valve gear are of forged steel. Each engine was designed to indicate 1,500 I. H. P. at 180 revolutions ,with 200 lb. steam pressure.

Special interest attaches to the boiler equipment of the *Pennsylvania,* as we believe this is the largest installation of water tube boilers of the "small tube" variety in a passenger vessel in American waters. There are six water tube boilers of the Almy type, built to work under forced draft at a pressure of 225 lb. per square in. They are fitted forward of the engines in two sets of three abreast, and fronting on a common athwartships fire room. Each boiler occupies a space about 8 ft. square, and the fire room is 12 ft. long in a fore and aft direction and 25 ft. wide. Each group of boilers is connected to its own stack. The space occupied by these boilers is shown in the cross section through the boiler room published on page 277.

The total grate surface is 363 sq. ft. and the total heating surface 10,960 sq. ft. The weight of the water tube boilers, filled with water to the steam level and including all furnishings except the breechings and smoke stacks, is 76 1-2 gross tons.

All auxiliaries are independent. There are two independent surface condensers, each with a centrifugal circulating pump, two vertical beam air pumps, two vertical duplex feed pumps, and also the usual ballast, bilge, and sanitary pumps. Steam steering engine is also fitted, and forward there are two steam lifts on the main deck for hoisting freight in and out of the hold, and there is also the usual equipment of steam capstan and windlass. A very complete electric lighting plant also forms part of the equipment.

The *Pennsylvania* was designed to meet the contract conditions which stipulated that she should be capable of steaming at the rate of 20 statute miles per hour on a draft of 9 ft. 6 in. when carrying 300 tons of freight, besides the coal, water, stores, and passengers. These are onerous conditions, but we understand that they have been fulfilled to the satisfaction of all concerned.

The *Syren and Shipping,* London, is authority for the statement that there is now under construction at the yard of Harland & Wolff, Belfast, Ireland, a steamship whose dimensions exceed those of the *Oceanic* of the White Star Line.

Belleisle Gunnery Experiments.

It is not often that in peace time naval officers have an opportunity to attack an ironclad with modern weapons, but this was made possible recently in the British Navy by the decision to use H. M. S. *Belleisle* as a target. The *Belleisle* is an iron, twin screw, central battery ironclad, built on the Thames in 1876. She was laid down for the Turkish government, but during the "We don't want to fight, but, by Jingo, if we do" period in England she was purchased for the British Navy. She turned out to be such a fearful roller at sea that she was assigned to harbor protection duty, in which she grew more and more out of date as the years went by. Her armor ranged in thickness from 12 in. down, and her armament consisted of four 12-in. muzzle loaders in the central battery and numerous smaller cannon. Her displacement was about 4,870 tons. Last month she was taken out from Portsmouth harbor and moored ready for action, with torpedo nets, out, etc., while the battleship *Majestic*, 14,900 tons, shelled her at a range of about one mile.

In the nine minutes that the firing lasted the *Belleisle* was completely wrecked in her unprotected portions, but strange to say—according to report—she was not seriously ablaze anywhere. Viewed from a distance the vessel seemed to be on fire, as much smoke enclouded her, but on close examination it was found that this was caused not by a general conflagration, but in part by the smoke from her uptakes—the funnel had been shot away—from unexploded lyddite shells, and from small pieces of wood which had been used as "dummies."

The lyddite shells (high explosive) fired by the *Majestic* had a terribly destructive effect The force of the explosions seemed to have been directed upwards, so that shells which entered the 'tween decks wrecked the structure above and below. From the guns of 3 in. to 12 in. caliber of the attacking vessel about 615 full service rounds were fired, and it was estimated that about 30 to 40 per cent struck the mark.

After the trial the *Belleisle* sank on account of the amount of water pumped into her. The holes in the sides were subsequently plugged and she was towed to dry dock at Portsmouth for survey. She will be refitted and again experimented with.

Among the United States Government publications, those issued by the Office of Naval Intelligence have always taken high rank on account of their authoritativeness and completeness, the thoroughly practical presentation of the subjects treated and timely character of the contents. The latest issue from this office is a complete record of the Coaling, Docking and Repairing Facilities of the Ports of the World and Analyses of Different Kinds of Coal. This information is in tabular form, the various parts being grouped according to their geographical locations, so that the inquirer can see at a glance what choice of ports there is in the particular waters he may be in. For ready reference the value of the book is increased by a comprehensive index. This publication measures 6 by 9 in., and contains 400 pages. It really represents an enormous amount of patient, careful work. Now that the country is reaching out after over-sea trade, its practical value to ships' officers is very great indeed.

EQUIPMENT FOR HANDLING BULK CARGOES RAPIDLY AT GREAT LAKE PORTS*—I.

BY ARTHUR C. JOHNSON.

Sir William H. White, Director of Naval Construction in the British Navy, in a recent review before the Institution of Mechanical Engineers, says: "One of the most marked tendencies in recent construction has been the increase in size and carrying power of ships. Unless there had been a corresponding development in the means of dealing with cargo, this increase in size could hardly have occurred, and the advantages resulting from that increase would not have been realized." Further he says: "It is well realized that unless there is 'quick despatch' in loading and unloading cargoes, very serious diminutions of earnings must result from the longer detention in port. Hence it follows that for the complete commercial success of the larger classes of cargo carriers, lifting appliances of the most efficient character and of ample capacity are of the greatest importance." If this is true of ocean going vessels, where voyages are on the average comparatively long and extended, to a much greater extent is it true of vessels carrying cargo on the Great Lakes, where even with rapid loading and discharging of cargoes, the ratio of time spent in port to that spent in transit is very great, amounting to one-sixth under the most favorable circumstances. The object of this paper is to deal with the special types of machinery built for the purpose of insuring "quick dispatch" in loading and unloading the enormous tonnage of ore and coal that is shipped annually on the Great Lakes—the foundation of the gigantic steel industry that has made the United States a competitor in the markets of the world. (See map of the Great Lakes, Fig. 1.)

The shipments of ore from Lake Superior Iron Ranges represents roughly one-third of the entire freight traffic on the lakes and for this reason a large fleet of modern cargo vessels has been built specially for this trade, represented as a type by the tow barge shown in Fig. 2, the steam barges being of the same general type. The largest of these are 500 ft. long and 50 ft. beam, the distinctive feature of these boats being the large size and number of hatches, 30 to 34 ft. long by 8 ft. wide, spaced 24 ft. centre to centre along the entire available deck length. This greatly facilitates loading and unloading operations, at the expense, however, of the strength of the deck plating, since the ship is almost cut in two crosswise of her deck. In Fig. 3 is shown the cross-section of a typical ore loading dock and the method of loading vessels. The ore is dropped into the pockets from drop-bottom "Jumbo" cars running on the tracks above, and from the pockets the chutes discharge the ore into the vessels lying alongside the dock. At the end of the season of 1898 there was at the different points a total of 4,354 pockets, having a total storage capacity of 623,612 gross tons of ore, constructed at a cost of about $7,000,000. The following table gives a list of docks with principal di-

*A paper read before the Civil Engineers' Club of Cleveland and contained in the Journal of the Association of Engineering Societies.

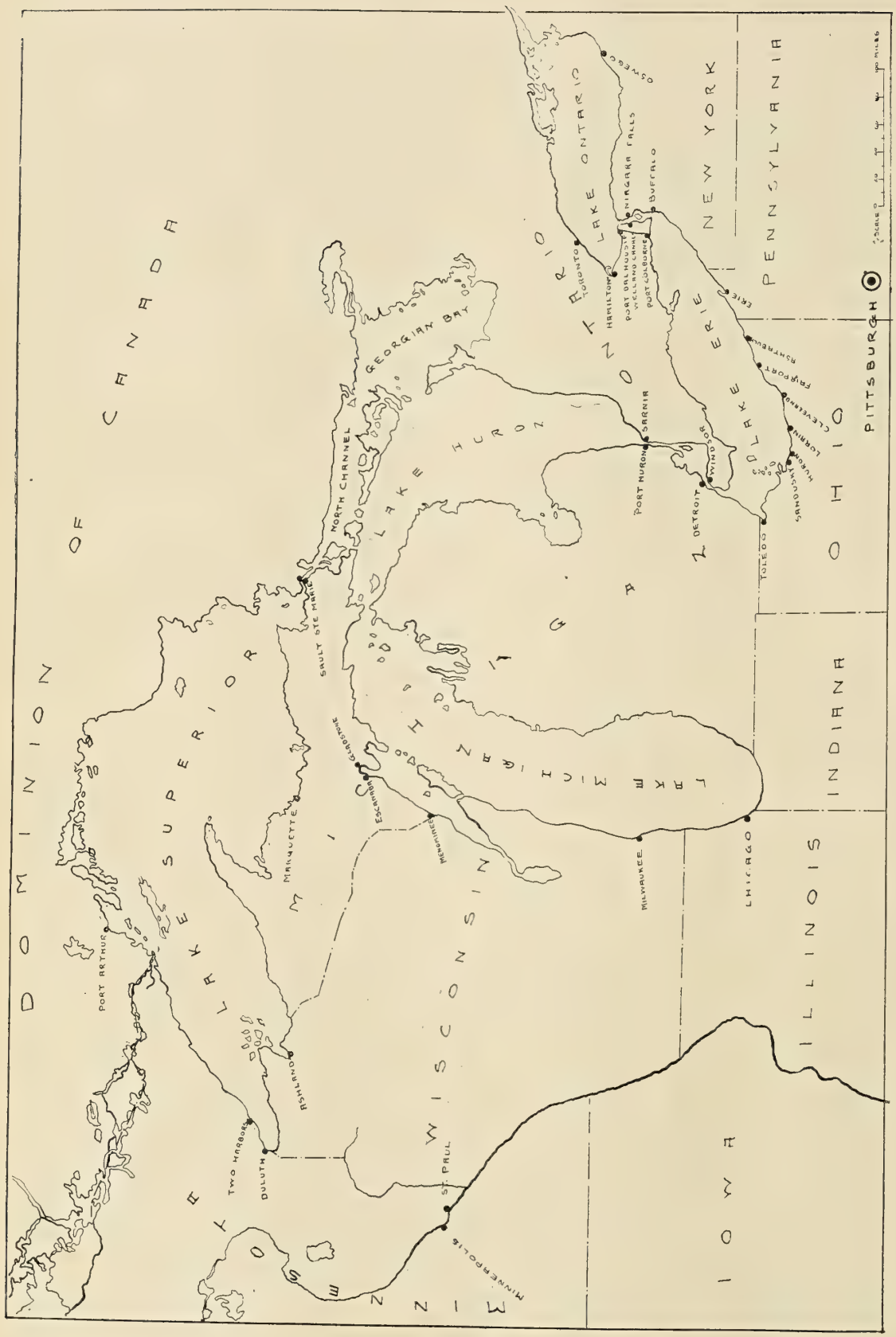


FIG. 1—SCALE MAP OF GREAT LAKES SHOWING PRINCIPAL LOADING PORTS FOR SHIPPING.

mensions and location and the names of the railway companies owning them.

Railway	Location	Dock No.	Length of Dock in ft.	Width of Dock in ft.	Height of Dock Water to Deck	No. of Pockets	Storage Cap'y Gross Tons
Duluth and Iron Range R. R. Co.	Two Harbors. Minn.	1	1,056	41′0″	45′ 6″	141	18,000
		2	1,248		57′ 0″	208	41,600
		3	340	49′0″	51′ 6″	90	16,000
		4	1,008	49′0″	51′ 6″	168	30,000
		5	1,008	49′0″	54′ 0″	168	33,000
Duluth, Masaba & Northern.	Duluth, Minn.	1	2,340	52′0″	53′ 6″	384	57,600
		2	1,738	52′0″	57′ 4″	288	42,200
Duluth, Superior & Western Ry.	Allouez Bay. Superior, Minn.	1	a- 300 b-1,200	49′8″ 49′8″	52′ 0″ 57′ 0″	40 190	12,000 25,500
Chicago & North Western R. R.	Ashland, Wis.	1	1,404	46′8″	54′ 0″	234	36,036
		2	1,404	46′0″	58′ 8″	234	24,156
	Escabana, Mich.	1	1,404	37′0″	46′ 0″	184	24,104
		3	1,356	37′0″	39′ 0″	226	30,284
		4	1,500	37′0″	59′ 2″	250	37,500
		5	1,392	37′0″	51′1c″	232	43,152
Duluth, South Shore & Atlantic R. R.	Marquette, Mich.	1	1,700	40′0″	45′ 0″	270	27,000
		3	1,200	53′6″	37′ 0″	213	12,780
		4	1,200	36′8″	47′ 3″	200	28,000
Lake Superior & Ishpeming.	do.	1	1,200	52′0″	54′ 0″	200	36,000
Minneapolis, St. Paul & Sault Ste. Marie R.R.	Gladstone, Mich.	1	768	37′0″	47′ 0″	120	15,000
Wisconsin Central Lines.	Ashland, Wis.	1	1,908	36′0″	54′ 6″	314	33,500

The Duluth, Masaba and Northern Ry. has now under construction a new dock which is 66 ft. 6 in. high and 62 ft. wide, the heel of the spout being 40 ft. above the water line. There will be 192 pockets, with a capacity of 21 tons each. The additional width permits the placing of a track along the centre of the dock for storing empty cars and minimizing the work of the switching engines. The dock proper will require 6,500,000 ft. of sawed timber and 4,780 pieces of piling.

The pockets of these docks can be filled with the different grades of ore ready to be discharged into the vessels as they arrive, and it is not an uncommon thing for a vessel to come alongside of one of these docks, take in a cargo of 5,000 tons of ore and depart within two or three hours from the time it reached port. In the busy seasons, however, the vessels are loaded directly from the cars by dropping the ore through the pockets. Timbers are placed across the lower hatch to break the fall of the ore, and with proper manipulation of the chutes an entire cargo can be loaded with little or no trimming. The following table gives the output of the Lake Superior ranges from 1895 to 1899, inclusive:

OUTPUT OF IRON ORE FROM ALL MINES OF THE LAKE SUPERIOR ORE REGION, 1895 TO 1899 INCLUSIVE.

Ports	1899	1898	1897	1896	1895
Escanaba	3,720,218	2,803,513	2,302,121	2,321,931	2,860,172
Marquette	2,733,596	2,245,965	1,945,519	1,564,813	1,079,485
Ashland	2,703,447	2,391,088	2,067,637	1,566,236	2,350,219
Two Harbors	3,973,733	2,693,246	2,651,465	1,813,992	2,118,156
Gladstone	381,457	335,955	241,014	220,887	109,211
Superior	878,942	550,403	531,825	167,245	117,884
Duluth	3,509,965	2,635,262	2,376,064	1,988,932	1,598,783
Total by Lake	17,901,358	13,655,432	12,215,645	9,644,036	10,233,910
Total by Rail	****	369,241	253,993	290,792	195,127
Total Shipments		14,024,673	12,469,638	9,934,828	10,429,037

Practically all this ore is unloaded at South Chicago for consumption there, or at some of the Lake Erie ports for consumption in the Pittsburgh District. The relative locations of these places will be seen on the map, Fig 1. One of the most recent and largest installations of ore unloading equipments is the plant on the docks of The Lorain Steel Company, built by the McMyler Mfg. Co., and shown in Fig. 4. The plant consists of four machines of three bridges each, the distinctive feature being the long cantilever of 127 ft. overhanging the boat, and the great length of bridge The bucket travels, on a return trip from the bottom of the boat to the extreme end of the rear cantilever, 940 ft. As will be seen, the ore can be dumped on the stock piles, or through the suspended hoppers into cars, which carry it to the furnaces, situated directly be-

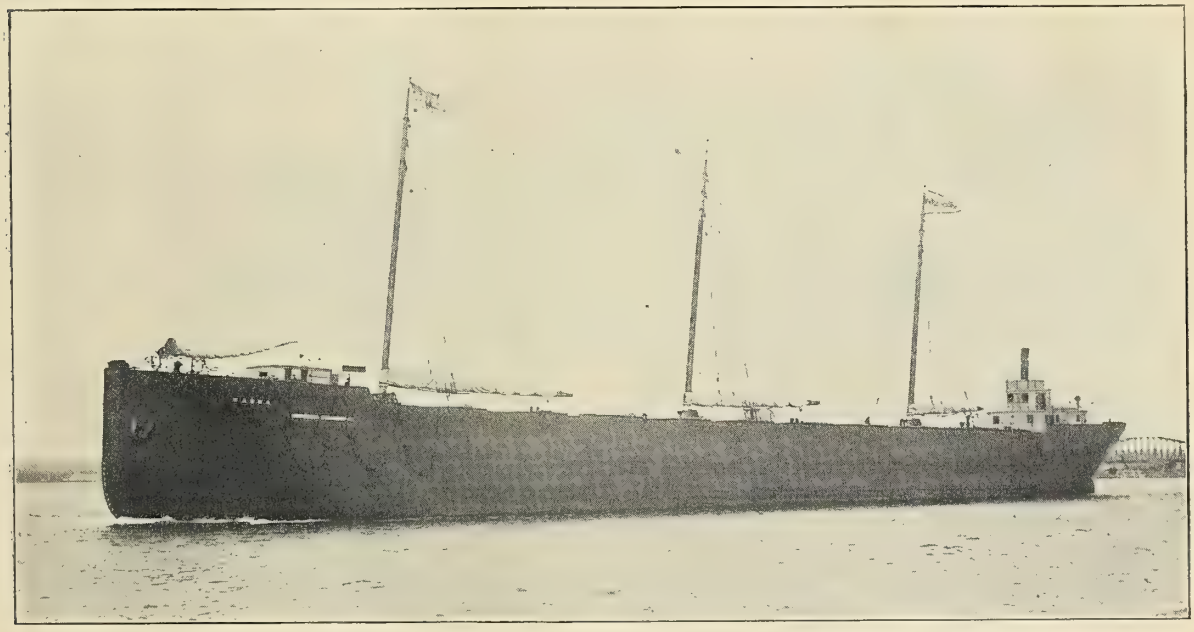


FIG. 2.—TYPICAL LAKE TOW BARGE FOR BULK CARGOES—LENGTH 352 FT., BEAM 44 FT., G. T. 3,259.

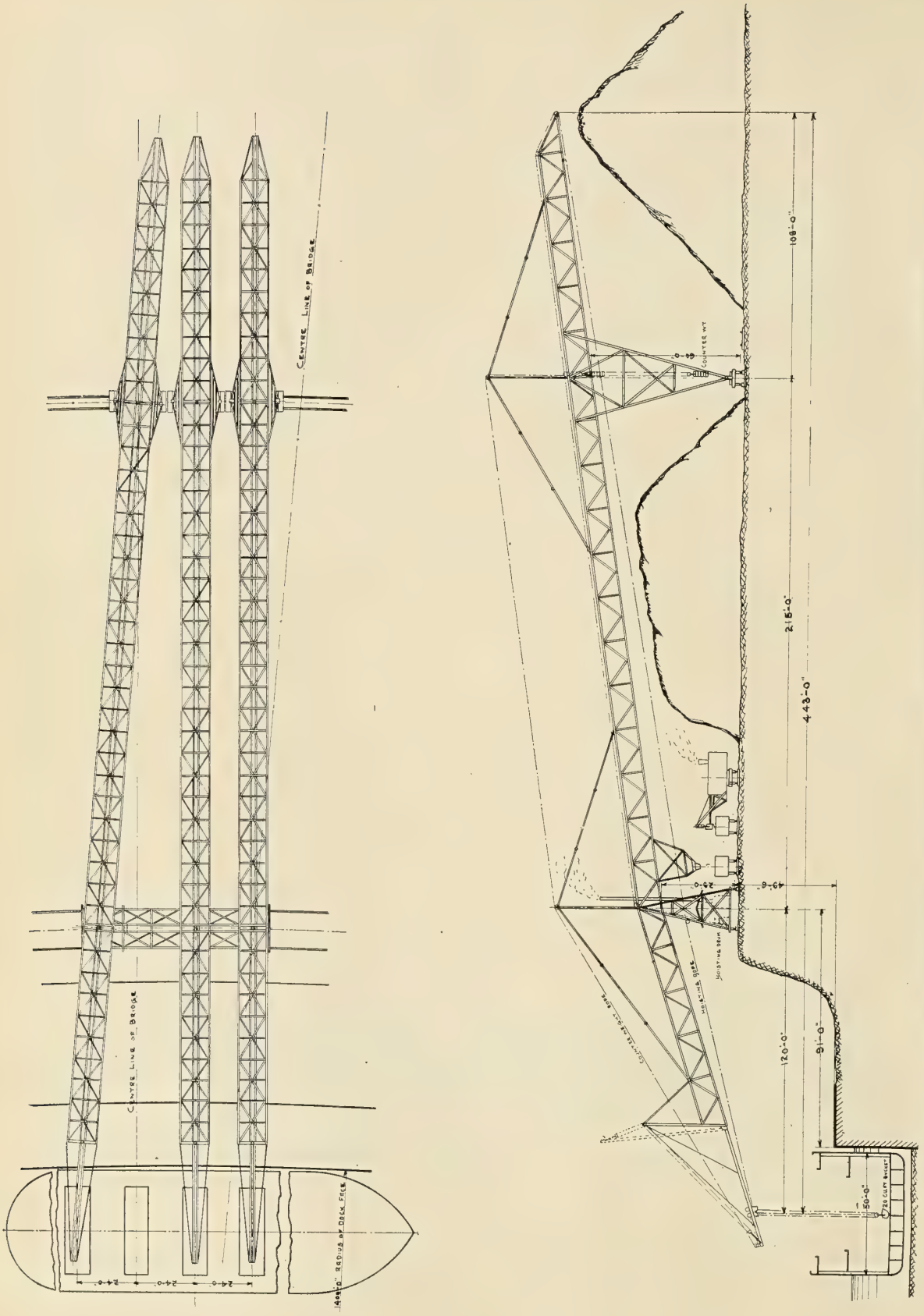


FIG. 4.—MC MYLER ORE UNLOADING EQUIPMENT IN USE AT THE DOCKS OF THE LORAIN STEEL CO., SOUTH LORAIN, OHIO.

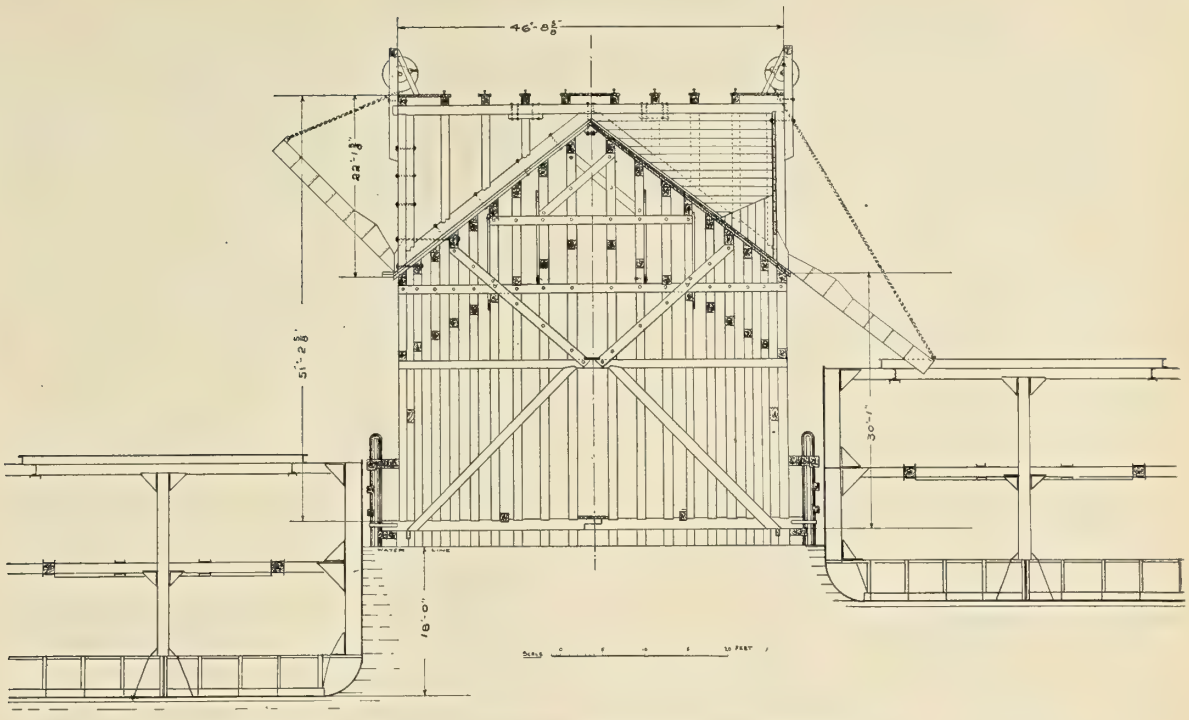


FIG. 3.—CROSS SECTION OF TYPICAL ORE-LOADING DOCK.

hind the hoists. In Fig. 5 is shown the wagon and front stop used on these machines, and Fig. 6 is a detail of the 20 cu. ft. bucket used. The most economical size of bucket for use in connection with ore hoists has been found to be from 17 to 20 cu. ft. capacity, as a larger bucket is so heavy for the shovelmen to handle that much time is lost. There are in 17 cu. ft. one gross ton of light soft ore, or 2,500 lbs. of hard ore. Each bridge of the conveyors shown in Fig. 4 is equipped with a pair of 12 in. by 12 in. non-reversing engines carrying a 40 in. drum directly on the crank shaft for the main hoisting rope. As will be seen from Fig. 5, the wagon is arranged with a "three part" hoist, but in traveling along the bridge the full circumferential

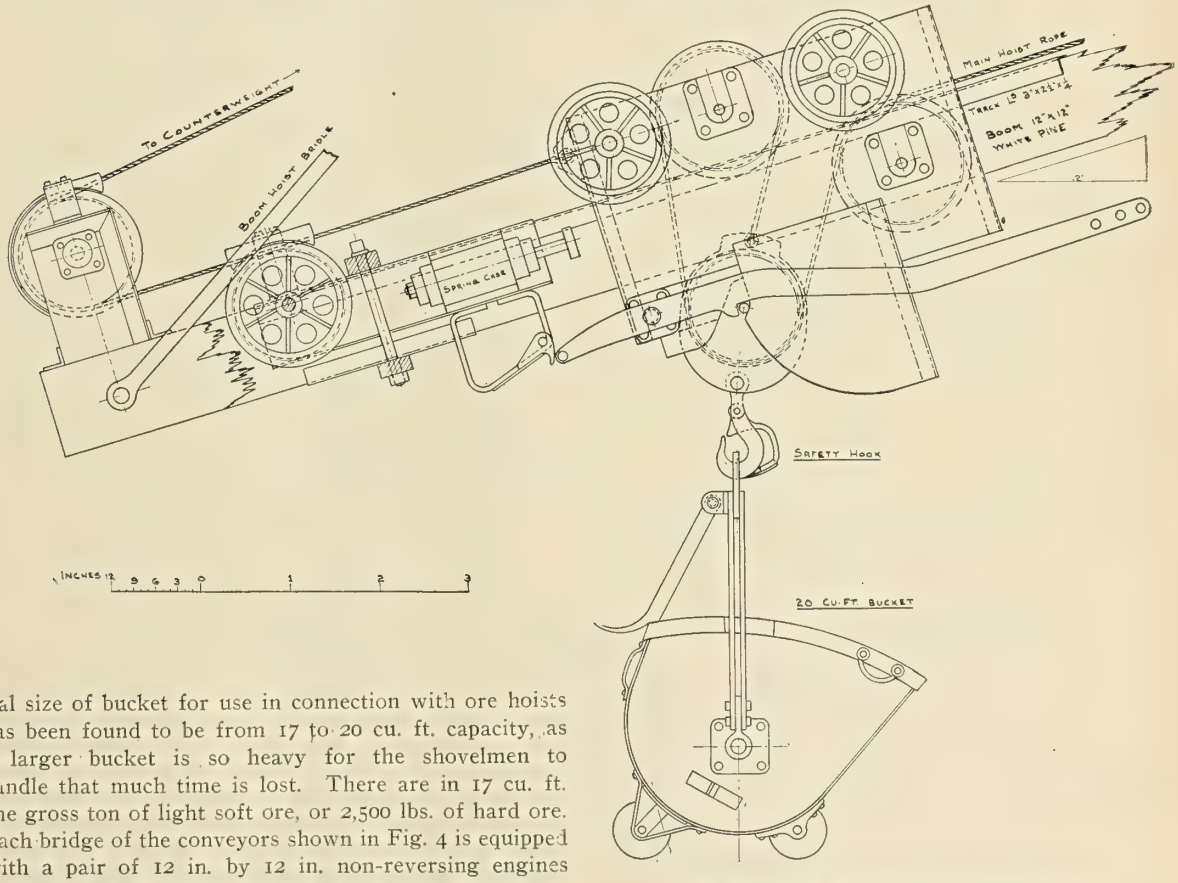


FIG. 5.—DETAIL OF WAGON AND FRONT STOP.

speed of the drum is effective on the wagon, so that a single revolution of the engine carries the wagon 10 ft. 5 in. along the bridge in trolleying, or lifts the bucket 3 ft. 5⅝ in. in hoisting, thus making the machines very quick in action. The incline of the bridge is aided in returning the wagon by a counterweight in the rear tower. The main hoisting ropes are 5-8 in. dia., 1-2 way between the towers. The best cargo record was 3,241 gross tons taken out in 12 1-2 hours by six bridges. The operator is located in the front tower in these machines, in full view of the hatch, which makes the matter of getting the bucket up and down through the hatch much easier and quicker than when he is further removed from the boat.

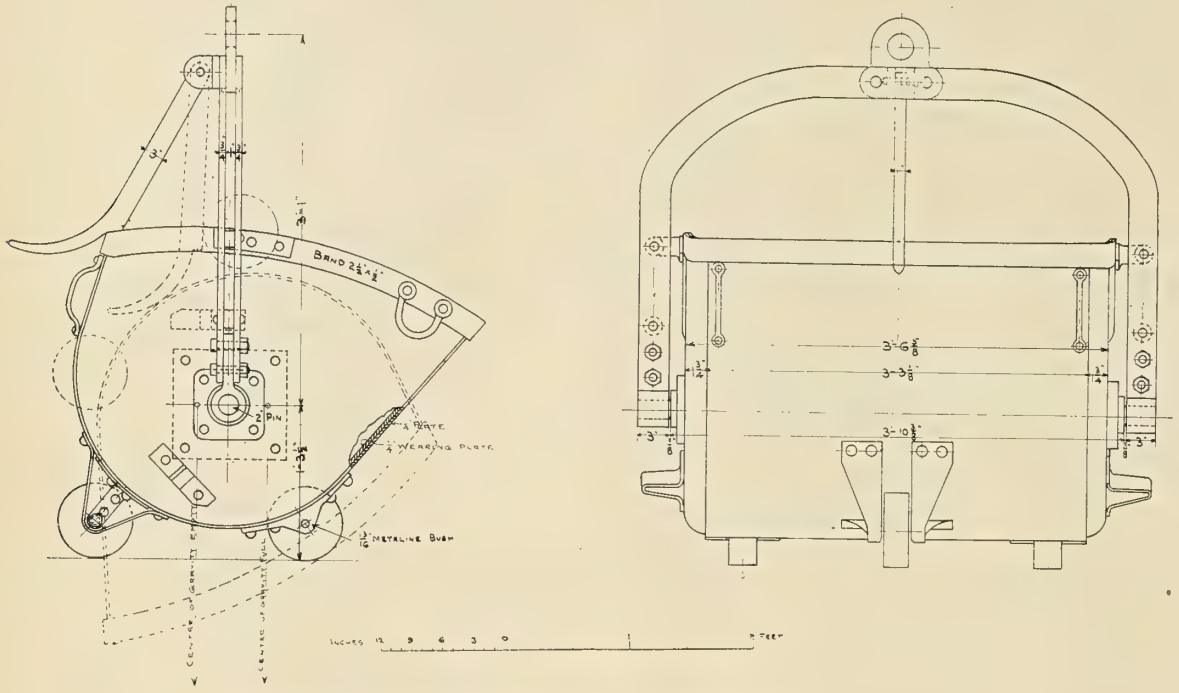


FIG. 6.—DETAIL OF 20 CU. FT. BUCKET FOR MCMYLER UNLOADER AT LORAIN.

in. ropes having been found too light for the severe service-running on 24 in. sheaves except in the wagon, where they are 17 in. and in the hanging blocks, where they are 14 1-2 in. dia. The engines have auxiliary drums for hoisting the boom or apron that overhangs the boat, and they are also arranged to move the front end of the bridges in or out from the centre bridge in order to accommodate any spacing of hatches, and to propel the front tower along the track parallel to the dock face. The rear towers are moved by a locomotive

In Fig. 7 is shown the type of unloader built by The Brown Hoisting and Conveying Machine Co., the pioneers in the building of dock machinery on the Lakes. It differs from the McMyler hoists already described in the type of towers employed and in the arrangement of the towers. The engines also have a single reduction gearing between the crank shaft and drum, thus using a smaller engine with higher piston speed. The machines are generally arranged in groups of two, with the engines and boilers, and operators in the rear tow-

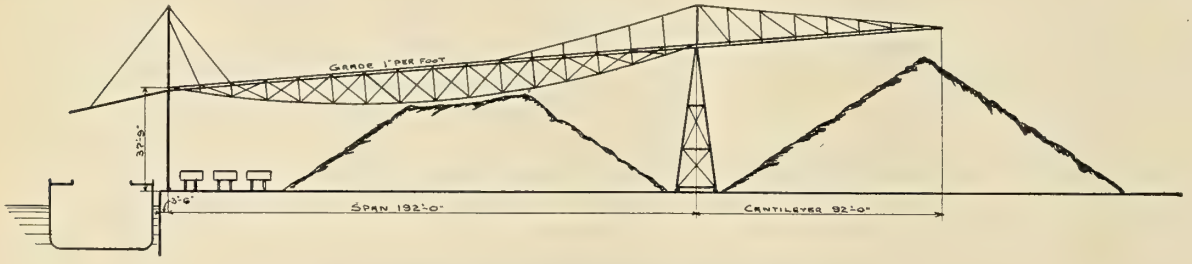


FIG. 7.—BROWN TYPE OF UNLOADER USED ON THE LAKES.

on a parallel track. The returning wagon is controlled by a band brake on the drum worked by the foot of the operator. These machines have made some remarkable records in point of speed, as an individual wagon has made 50 return trips per hour, carrying the bucket from the bottom of the boat to a point half

er. Both towers are generally moved along the dock by hand. There are over 175 bridges of the Brown type of conveyor at the different Lake Erie ports.

In Fig 8 is shown yet another type of ore unloader built by the King Bridge Company, the distinctive feature being the great freedom of motion of the

bucket. In both the Brown and McMyler type, the hanging block is locked in the wagon and cannot be released without striking a stop which is bolted between the tracks. Thus, when unloading very narrow boats, the front stop on the apron must be moved in until it is vertically over the centre of the hatch; and similarly for loading into a car on a track under the rear cantilever, a stop must be placed over the centre of the track to allow the bucket to be lowered in order to reduce the drop of the ore. In the King machines, however, the bucket can be raised or lowered to any desired height simultaneously with its travel along the bridge. The dock records of Conneaut Harbor show that nothing is lost in point of speed of operation, and considering its advantages, it is surprising that the system has not been used to a much greater extent, its only disadvantage being that three drums and reversing engines are required for its operation.

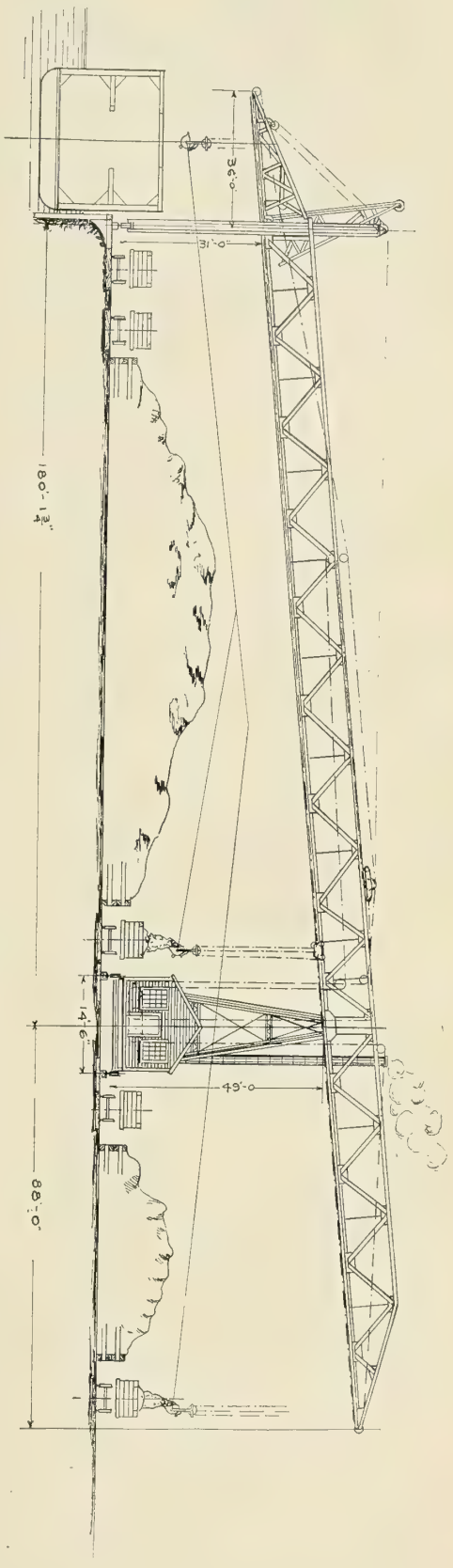


FIG. 8.—TYPE OF ORE UNLOADER BUILT BY THE KING BRIDGE CO., IN USE AT THE CONNEAUT HARBOR ON THE GREAT LAKES.

Changes in Lloyd's Rules for Shafting.

Changes in the rules for determining the dimensions of shafting were recently decided upon by Lloyd's Register and are now in force. The amended paragraphs are referred to by their numbers and are as follows:

SHAFTS.

30. All shafts are to be made of good material and are to be examined when rough turned and when finished. In the case of screw shafts scrap steel is not to be used. It is recommended that these be made of ingot steel or forged from blooms made from rolled iron bar of good fibrous quality.

31. Gauges of an approved description for testing the truth of the crank shafts are to be supplied with all new engines, and adjusted in the presence of the surveyor.

32. The length of the stern bush is to be at least four diameters of the shaft. It is recommended that the shaft liner should be continuous the whole length of the stern tube, and that the after end should be tapered in thickness and made watertight in the propeller boss. If the liner is made in two pieces the joint should be burned. If the liner does not fit tightly at the part between the bearings in the stern tube, the space between the shaft and the liner should be charged or "forced" with a plastic material insoluble in water and non-corrosive. If two liners are used, it is recommended that they be tapered in thickness at the ends, and that the shaft should be lapped or protected between the liners. In this case, and also if no liners are used, the diameter of the shaft should be $\frac{21}{20}$ths of that required for a shaft with a continuous liner.

For dimensions of shafts, see the formula in paragraph 59.

RULES FOR DETERMINING SIZES OF SHAFTS.

59. The diameters of intermediate shafts are to be not less than those given by the following formula:

For compound engines with two cranks at right angles:

Diameter of intermediate shaft in inches =

$$(\cdot 04\,\mathbf{A} + \cdot 006\,\mathbf{D} + \cdot 02\,\mathbf{S}) \times \sqrt[3]{\mathbf{P}}$$

For triple expansion engines with three cranks at equal angles:

Diameter of intermediate shaft in inches =

$$(\cdot 038\,\mathbf{A} + \cdot 009\,\mathbf{B} + \cdot 002\,\mathbf{D} + \cdot 0165\,\mathbf{S}) \times \sqrt[3]{\mathbf{P}}$$

For quadruple expansion engines with two cranks at right angles:

Diameter of intermediate shaft in inches =
$(\cdot034\,\mathbf{A} + \cdot011\,\mathbf{B} + \cdot004\,\mathbf{C} + \cdot0014\,\mathbf{D} + \cdot016\,\mathbf{S}) \times \sqrt[3]{\mathbf{P}}$

For quadruple expansion engines with three cranks:
Diameter of intermediate shaft in inches =
$(\cdot028\,\mathbf{A} + \cdot014\,\mathbf{B} + \cdot006\,\mathbf{C} + \cdot0017\,\mathbf{D} + \cdot015\,\mathbf{S}) \times \sqrt[3]{\mathbf{P}}$

For quadruple expansion engines with four cranks:
Diameter of intermediate shaft in inches =
$(\cdot033\,\mathbf{A} + \cdot01\,\mathbf{B} + \cdot004\,\mathbf{C} + \cdot0013\,\mathbf{D} + \cdot0155\,\mathbf{S}) \times \sqrt[3]{\mathbf{P}}$

where **A** = diameter of high pressure cylinder in inches,
B = diameter of first intermediate cylinder in inches,
C = diameter of second intermediate cylinder in inches,
D = diameter of low pressure cylinder in inches,
S = Stroke of pistons in inches,
P = Boiler pressure above atmosphere in lbs. per square inch.

60. The diameter of crank shaft and of thrust shaft under the collars, to be at least $\frac{21}{20}$ths of that of the intermediate shaft. The diameter of thrust shaft may be tapered off at each end to the same size as that of the intermediate shaft.

61. The diameter of the screw shaft to be equal to the diameter of intermediate shaft (found as above) multiplied by $\left(\cdot63 + \frac{\cdot03\,\mathbf{P}}{\mathbf{T}}\right)$, but in no case to be less than $1\cdot07\,\mathbf{T}$,
where **P** is the diameter of propeller, and
T the diameter of intermediate shaft, both in inches.

This size of screw shaft is intended to apply to shafts fitted with continuous liners the whole length of the stern tube, as provided for in paragraph 32. If no liners are used, or if two separate liners are used, the diameter of the shaft should be $\frac{21}{20}$ths that given above.

The diameter of screw shaft is to be tapered off at the forward end to the size of the crank shaft.

62. NOTE.—The rules are intended to apply to two-cylinder compound engines, in which the ratio of areas of low and high pressure cylinders does not exceed 4.5 to 1; the triple expansion engines in which it does not exceed 9 to 1; in quadruple expansion engines in which it does not exceed 12 to 1; and in all cases, as regards the stroke, in which the length of stroke is not less than one-half the diameter or greater than the diameter of the low-pressure cylinder. Engines of extreme proportions beyond these limits being specially submitted to be dealt with on their merits.

PERIODICAL SURVEYS.

65. The stern shaft is to be examined annually and drawn at intervals of not more than two years.*

These new rules are the result of a long continued investigation made by the technical committee of Lloyds.

* On the application of owners, the Committee will be prepared to give consideration to the circumstances of any special case.

DIRECT APPLICATION OF ELECTRICITY TO THE PROPULSION OF SHIPS.

A Reply to Certain of the Statements Made by Nikola Tesla in the June, 1900, Issue of "The Century Magazine."

BY WILLIAM F. DURAND.

In the June number of *The Century Magazine* is found an article from the pen of Mr. Nikola Tesla, in which the author discusses in a decidedly transcendental manner the problem of "increasing human energy." It would not be difficult to join issue with Mr. Tesla regarding some of the fundamental assumptions made, as for example, that *mechanical energy,* expressible by formula $MV^2 \div 2$, or in terms of mass and velocity as we know them, can fully represent the quality of the operations of the human mind. This is simply begging a question regarding which we are profoundly ignorant, a question regarding which we have no sure facts, and therefore in regard to which it is in the last degree unscientific to make the assumptions implied by the author.

The chief interest lies, however, with the transcendental and hypothetical conclusions drawn from these assumptions, and among them are found two or three relative to the application of electricity to marine propulsion. These conclusions are utterly incorrect and in direct antagonism with the laws of nature, and taking into account the standing in literary circles usually accredited to *The Century Magazine* and the popular reputation as an electrician usually accredited to the author, it would seem proper to point out the nature of these errors, lest by those not technically qualified to judge, such absurdities might be considered as having some foundation in fact.

On page 198 are found the following statements:

> Instead of driving the machinery in a factory in the old wasteful way by belts and shafting, we generate electricity by steam power and operate electric motors. In this manner it is not uncommon to obtain two or three times as much effective motive power from the fuel, besides securing many other important advantages. It is in this field as much as in the transmission of energy to great distances that the alternating system, with its ideally simple machinery, is bringing about an industrial revolution. But in many lines this progress has not yet been felt. For example, steamers and trains are still being propelled by the direct application of steam power to shafts and axles. A much greater percentage of the heat-energy of the fuel could be transformed in motive energy by using, in place of the adopted marine engines and locomotives, dynamos driven by specially designed high-pressure steam or gas-engines, and by utilizing the electricity generated for propulsion. A gain of fifty to one hundred per cent in the effective energy derived from the coal could be secured in this manner. It is difficult to understand why a fact so plain and obvious is

> not receiving more attention from engineers. In ocean steamers such an improvement would be particularly desirable, as it would do away with noise and increase materially the speed and the carrying capacity of the liners.

It is more especially with respect to the latter part of the quotation that we are here concerned. The proposition in brief is to displace the usual type of marine engine by "specially designed high-pressure steam or gas engines," driving electric generators, the electrical energy thus developed being then carried to an electric motor attached to the propeller shaft. In other words, an electric generator and motor are to be interposed between the engine and the propeller-shaft. Now let us examine this proposition, regarding the likelihood of an increase of efficiency similar to that promised in the quotation given above.

In the first place not the slightest grain of superiority or improvement in efficiency due to the use of the "specially designed high-pressure steam or gas engine will be conceded. Any such motor which can be used to operate an electric generator can also be used to operate a propeller direct, and without the interposition of the generator and motor. Screw propellers are designed and operated at speeds of revolution from 100 per minute and less to 2,000 per minute and over, and as an instrument of propulsion it is as fully capable of utilizing any gain in the efficiency of the prime-mover as is an electric generator. In any event the use of a screw propeller is assumed, and it is evident that it will be an element of equal value in either scheme of powering and propulsion.

Further, as to the high pressure steam engine, where shall we find anything higher than the 300 to 400 lbs., which is accepted and involved in present day practice with torpedo boats, fast launches, yachts and cruisers? Again, with regard to engine efficiency, where in present practice shall we go to better the record of the S. S. *Kensington,* 8,000 I. H. P., with her service record of about 1.00 lb. of coal per I. H. P. for the main engines? Again, regarding gas engines on board ship, the weight which present practice seems to find necessary for their safe construction and efficient operation is entirely prohibitive of their use when the highest results are to be attained. Then as a practical problem how would a designer of gas engines like to undertake the design and guarantee performance of a gas engine of, say, 10,000 I. H. P.? Or if, otherwise, such total power were to be split up into a number of small units the whole scheme immediately breaks down by reason of its complexity and weight. Then there is the further question of the cost of gasoline or other hydrocarbon, and of the enormous increase of output which would be required in order to make possible its use on any large scale; or if the gas is to be made from coal, is each ship to carry gas works in the fore hold, or is the gas to be stored in the bunkers and double bottoms?

All these considerations of detail, however, are beside the main point, which, as already noted, is that no claim of superiority whatever can be admitted for the use of any special type of prime-mover, since for utilizing the increased efficiency of any such improved steam or gas engine, the propeller is quite as capable as the electric generator.

The question simplifies therefore to the following: Given two steam engines or other prime-movers of equal efficiency, to compare the two schemes for ship propulsion in one of which the prime-mover is attached directly to the propeller shaft; and in the other, of which there is interposed between the two an electric generator and motor. If the gain of from 50 to 100 per cent promised by Mr. Tesla is to be realized at all, it must therefore come in as a result of these additional transformations of energy. Now, one of the first things which the engineer learns in his dealings with energy is that all transformations are sources of loss. This is a fact so simple and so fundamental that it cannot be overlooked, least of all by one who has given his life to the study of problems involving the transformation and use of energy in various forms. Yet here we find a proposition to interpose between the steam engine and the propeller two transformations or changes of energy, one from the mechanical form in the engine to the electrical form in the generator, and the other a change back to the mechanical form in the motor. There will also be a further loss due to transmission from the generator to the motor, but on board ship this will be very small and may be neglected. Taking as a basis of estimate the actual achievements of electrical engineering at the present day, the best combined efficiency which could be expected for this double transformation would be perhaps 90 per cent, though probably 85 per cent might be a safer estimate. In other words, of the energy supplied by the steam engine from 10 to 15 per cent would be lost as a result of the electrical transformations. So to take the more favorable case, for every 100 horse power delivered by the engine, 90 will reach the shaft instead of 100 as in the case of direct connection between engine and propeller. Yet to these transformations of energy which by the law of the conservation of energy must result in a loss, we are to look, if anywhere, for a gain of from 50 to 100 per cent, so that in the preceding case instead of 90 delivered horse power or thereabouts, as would actually be the case, we are to look for from 150 to 200. This would mean simply the creation of energy, and is a dream of perpetual motion in its baldest form. Such a proposition is a not unworthy fellow to those which have but recently been put before the public in connection with the liquid air absurdities.

Mr. Tesla knows, however, too well the doctrine of the conservation of energy to base any expectation of gain upon transformations which he knows must give rise to a loss, and it is therefore only fair to assume that his faith was pinned to the gain expected from the "specially designed high-pressure steam or gas engine," a gain which would reduce the cost of power in terms of fuel to one-half or two-thirds of the figures representing the best present practice. This especially designed engine would apparently also be of such peculiar type that while available for operating an electrical generator it could not be used for turning a screw-propeller. It may perhaps be in order to suggest that the design for such a prime-mover should be forthcoming in order to substantiate the claim, and until such an engine is produced all such claims for possible gain must be considered as without foundation, and instead of gain there is the certainty of loss. There may also have been some

expectation of gain by a shortening of the line shafting, or in greater uniformity of turning effort in the propeller. There is ground for expecting small gains due to these features, but so small as to be utterly inconsiderable and without practical influence on the main features of the problem. These points only merit mention in order that all sources of gain for the electrical scheme may be noted.

The author's naive curiosity as to why a method which promises so great a saving should have received so little attention from engineers is at the least amusing. Does he suppose that marine engineers are ignorant of the trend of advancement in the electrical field? Does he suppose that if there were any reasonable hope of increasing the efficiency by 50 to 100 per cent that it would not receive some attention from those most interested? If there were any likelihood of cutting the consumption of coal per day on a "liner" from, say, 400 tons to 200 or 275; that is a saving from 125 to 200 tons per day, and of increasing the cargo capacity by perhaps 1,000 tons for the trip, would those most interested long delay the adoption of such means? The truth seems to be that this so-called "fact," plain and obvious as it may seem to Mr. Tesla, is less plain and less obvious to those who are actually doing the world's work in the field of marine design and construction. If there is any one fact that is plain and obvious to them it is that a multiplication of changes of energy means a loss, and the proposition to interpose additional changes between the prime-mover and the propeller will be apt to receive from them small consideration so long as the laws of nature remain as they now are.

There is still another interesting side to this proposition, and that is, the price which must be paid for the apparatus; that is, for the generators and motors. The first point to be made is that the price is two-fold; one the price in terms of money, and the other the price in terms of weight.

If we confine ourselves to actual achievement in electrical engineering we shall hardly find builders of generators and motors ready to guarantee results for much less than 20 to 30 lb. per H. P., and these figures will require most careful design and might easily rise to 50 lb. and over. The installation of generators and motors will therefore mean the addition of, say, 50 lb. and upward per H. P. This would just about double the weight of machinery on a modern torpedo boat, for which in recent practice the engines and boilers together weigh 50 lb. or less per I. H. P. Let us compare the figures for a torpedo boat with 3,000 I. H. P.:

	STEAM EQUIPMENT.	STEAM AND ELECTRICAL EQUIPMENT.
Hull	56 tons	56 tons.
Coal, ordnance and stores	37 "	37 "
Machinery	67 "	134 "
Total	160	227

The displacement of the boat would thus be increased by about 67 tons, or from 160 to 227, while the power delivered to the propeller shaft would be decreased by, say, 300 H. P. The joint effect of these would be a reduction in the speed of the boat by about 3 knots, or from, say, 25 knots to 22. These results are hardly such as would be apt to commend themselves to naval designers.

Again, with a "liner" having, say, 25,000 I. H. P., the addition of electrical machinery of suitable type would result in adding perhaps 1,500,000 lb., or about 700 tons to the machinery weights. For the same total displacement this would mean the loss of about 700 tons of paying cargo, and a further loss of about 2,500 horse power as a result of the electrical transformations, decreasing the speed by from 1-2 to 3-4 knot. When we remember that on the modern "liner" the margin of weight left for paying cargo is quite small, usually not exceeding a maximum of 2,000 tons, it is apparent that the loss of 700 tons or more would result in a most serious reduction in the earning capacity of the vessel. The "increase" of carrying capacity referred to at the close of the quotation would be therefore of a character not likely to commend itself to the stockholders or board of directors.

The price to be paid in cash will depend on the current prices for electrical machinery of such types and sizes as may be required, but it will not be far wrong to say that the cost of the electrical equipment would be not less than that of the steam equipment, and that the cost of the total equipment would therefore be not less than double what it is with the present methods of powering and propulsion. The interest on this added first cost would make a most serious inroad upon the small margin of profit now obtainable from investments in this field of commerce.

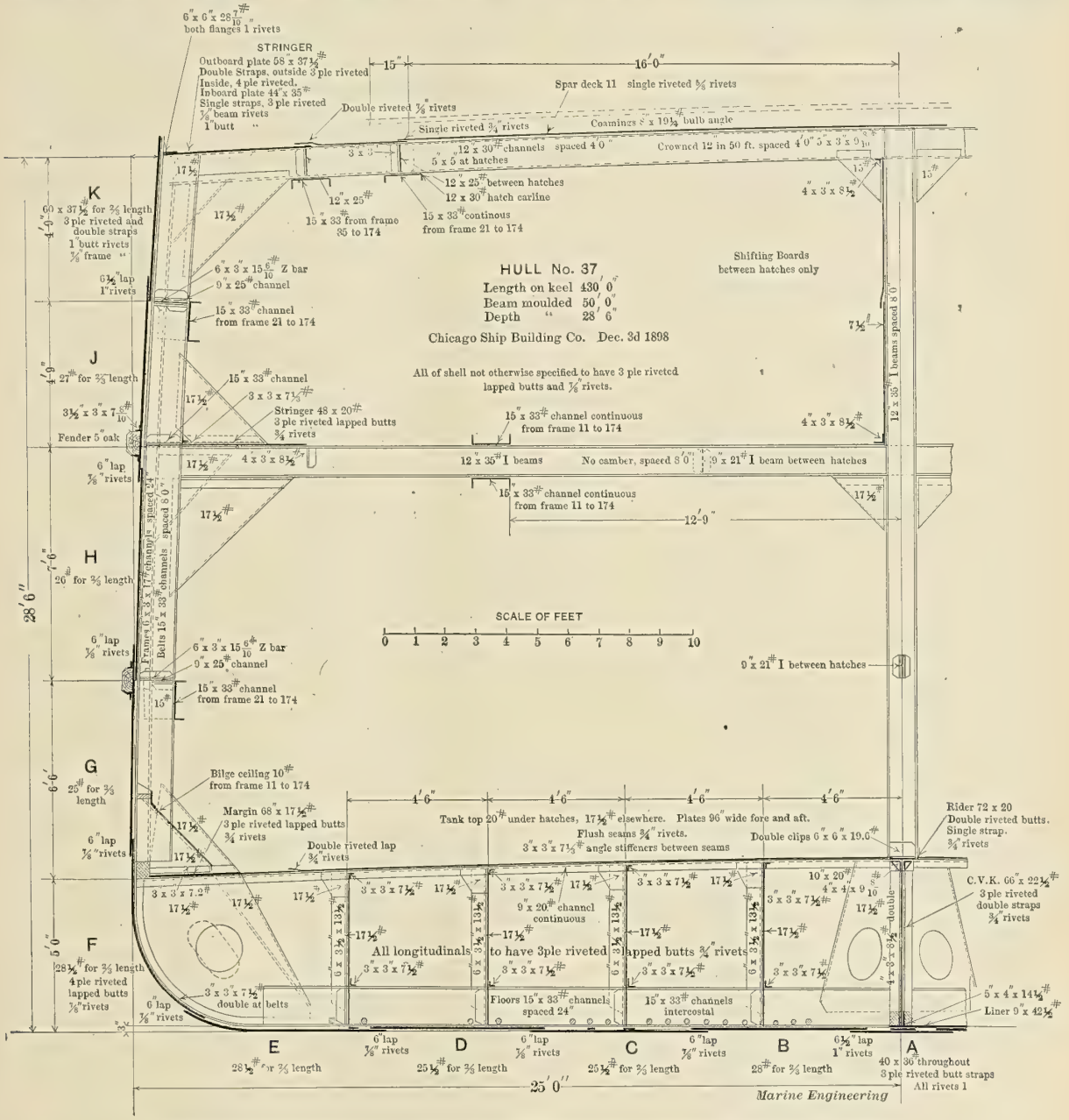
A passing reference may also be made to the statements in the early part of the quotation relating to the substitution of electric generators and motors for lines of shafting and belting, whereby it is claimed that two or three times as much effective power may be obtained as by the old and wasteful methods. From what has preceded it is clear that the substitution of electric generators and motors for shafting and belting is a substitution of one form of loss for another, and the final balance will depend on which is the greater of the two. If the belting and shafting scheme is long and complicated and perhaps in poor mechanical condition as well, there will undoubtedly result a gain in efficiency for the electrical scheme. If it is short and direct and in good condition, the advantage will remain with the mechanical transmission. In no normal or ordinary case, however, will the gain amount to anything approaching 100 to 200 per cent. In fact, the question of fuel economy in such cases is only one of many considerations, and not always the most important. In cases where such installations have been made it is probable that other considerations have weighed quite as much as that of economy of fuel. Among such special advantages for the electrical scheme are the following: Independence of operation, entire freedom in locating machines without reference to lines of shafting, etc., absence of line shafting, countershafts, etc., and consequent greater freedom for the operation of cranes and handling gear.

Russian Cruiser Variag.—A builders' trial of the Russian cruiser *Variag*, built at Cramps', Philadelphia, was carried out last month. With about 150 engine revolutions (17,000 I. H. P.) a speed of 22 knots was reported to have been attained, natural draft.

SYSTEM OF WORK ADOPTED IN A SHIPYARD ON THE GREAT LAKES—II.*

BY W. I. BABCOCK.

All the work is now carefully bolted, reamed by pneumatic drills, and is ready for riveting, which is started at once amidships by pneumatic yoke riveters for the inside and by pneumatic shell riveters for the bottom plating, nearly all the rivets in the hull being machine driven. As soon as the channel seam straps punched, rolled, and bolted up in position. That these plates are not gotten out from moulds like the others is principally because the very careful work on a surface of so sharp a curve is too expensive. At the lapped butts it is evident that the radius is greater for the outside plate than for the inside, and in any rolled plate the necessary difference between the lengths of the two surfaces is obtained sometimes by compression on the inside and sometimes by extension on the outside, and there is no way of determining beforehand which will


STRINGER
Outboard plate 58 x 37½#
Double Straps, outside 3 ple riveted
Inside, 4 ple riveted.
Inboard plate 44 x 35#
Single straps, 3 ple riveted
⅞" beam rivets
1" butt "
Double riveted ⅞" rivets
Single riveted ¾" rivets
Spar deck 11 single riveted ⅝ rivets
Coamings 8 x 19⅓ bulb angle
12 x 30# channels spaced 4'0"
5 x 5 at hatches
Crowned 12 in 50 ft. spaced 4'0"
12 x 25# between hatches
12 x 30# hatch carline
15 x 33# continous from frame 21 to 174
15 x 33# from frame 85 to 174
HULL No. 37
Length on keel 430' 0"
Beam moulded 50' 0"
Depth " 28' 6"
Chicago Ship Building Co. Dec. 3d 1898
Shifting Boards between hatches only
All of shell not otherwise specified to have 3 ple riveted lapped butts and ⅞" rivets.
12 x 35# I beams spaced 8'0"
No camber, spaced 8'0"
9" x 21# I beam between hatches
15" x 33# channel continuous from frame 11 to 174
Stringer 48 x 20# 3 ple riveted lapped butts ¾ rivets
Fender 5" oak
SCALE OF FEET
0 1 2 3 4 5 6 7 8 9 10
Tank top 20# under hatches, 17½# elsewhere. Plates 96" wide fore and aft.
Flush seams ¾" rivets.
3" x 3" x 7½# angle stiffeners between seams
Double clips 6" x 6" x 19.6#
Rider 72 x 20 Double riveted butts. Single strap. ¾" rivets
Bilge ceiling 10# from frame 11 to 174
Margin 68" x 17½# 3 ple riveted lapped butts ¾ rivets
Double riveted lap ¾" rivets
9" x 20# channel continuous
All longitudinals to have 3ple riveted lapped butts ¾" rivets
Floors 15" x 33# channels spaced 24"
15" x 33# channels intercostal
C.V.K. 66" x 22½# 3 ple riveted double straps ¾" rivets
5" x 4" x 14½# Liner 9" x 42½#
40 x 36 throughout 3 ple riveted butt straps All rivets 1
Marine Engineering

HALF CROSS SECTION OF S. S. MAUNA LOA—TYPICAL LAKE FREIGHTER FOR BULK CARGOES.

and ties are riveted to the bilge brackets, the tank margin plates are put on and the angle on top of same for the bracket connections, and all riveted.

The bilge plates are now templeted from the work, occur. Further than this comes in the slight irregularity in the height of the floor ribbands, the effect of which is magnified at the bilges, increasing the chance of bad holes and spoiled plate. While the use of this mould system requires in any event a good solid foundation under the ship, it must be remembered that this is

*Read at the seventh general meeting of the Society of Naval Architects and Marine Engineers, held in New York.

only piling; that shores and blocking are of wood, only roughly cut to length and wedged up; and that rib-bands are also of wood, supported only at intervals, and lined up principally by a ship's carpenter's eye. While our experience has amply proven that for such parts of the bottom as have been already described—all straight work—these sources of error are quite negligible, that is not so with the bilge plates, even amidships, and it is much cheaper to templet these plates than to spend the time and money necessary to bring the framework of the tank to such perfection of outline and spacing that mould work could be depended upon in all cases.

With the bilge plates in place, the water bottom for the straight midship body of the ship is completed. The remainder of the shell plating within the limits of the water bottom, the margin plates and other plates of the tank top are templeted off in the ordinary manner.

In the meantime, the channel frames and belts for the sides of the ship above the tank for the straight midship body and for some distance forward and aft of same—until the curvature becomes too great and beveling commences—have been cambered cold in a heavy power bending press. These frames and belts having been ordered to lengths taken directly from the mould-loft floor, the variation in length is very slight from what is actually required, and is taken up at the lower ends, which stop about 4 in. short of the margin plate of tank to form a water-way. The main-deck line and side stringers, and the plate edges of all side strakes, are run in parallel to the upper deck sheer. One mould for the web and one for each flange of frames and bolts, therefore, answer for all holes down to and including the lower side stringer. The holes at the bottom for the rivets connecting the channel frame or belt to the tank-top bracket are put on from the same mould, but as these holes are set to a level line, which is the height of the top of the center vertical keelson, the mould must be moved down at each frame a distance equal to the raise of the sheer at that frame, these sheer heights of spar deck being marked on the upper end of the mould.

The spar-deck beam brackets and the main-deck lower brackets are now laid out, each from its own mould, for all that part of the ship for which the tumble-home is constant, punched, bolted on to the frames and belts, and riveted by the stationary riveter. The spar-deck beams are cambered and, with the straight main-deck beams, stanchions, shifting boards, channel ties and struts and 'thwartship hatch coamings, laid out from moulds and punched. Side stringer channels, which are in short lengths between belts, and Z-bar clips between frames are laid out, punched and riveted together on the ground by portable yoke riveters. Main-deck stringers for the straight body are laid out and punched, with the channel intercostal to the skin between belts, which is scored out to allow the frames to pass through.

The three upper strakes of the side plating for the straight side are now laid out, punched, and countersunk. For the lowest of the three, the maindeck sheer, this does not include any more plates than those on the midship body, as the frame line begins to leave the tumble-home line at its lower end immediately the extremities of the dead flat are passed, the point of departure going higher with each frame. The between-deck strake has a larger number of plates on the flat side and the sheer strake the most of all. For laying out these shell plates a slip mould is used. I believe that this method of laying out side plating is original with Superintendent E. Gunnell, of the Chicago Ship Building Co., to whom, in fact, most of the development of the system is due.

This mould is based on the principle of working from a level line parallel to the keel of the ship. The mould itself is square, the length inside of the end pieces being the exact length of the plate. At about its center a straight line is marked across it. The frame strips and butt lap moulds are entirely separate from the main mould and have similar lines marked upon them, one butt mould having in addition a scale of inches marked on it, starting from the line at zero. The fitter is furnished with a table, prepared for the mould-loft floor, showing the sheer height of the spar-deck line at each butt.

The squaring mould is now placed on the plate, the line on one butt mould brought into exact accordance with the line on one end of it, and the other butt mould raised until its line is a distance above the level line on the squaring mould equal to the raise in the sheer from the table. A chalk line is then stretched between the two ends, snapped on, and the mark on each frame strip brought exactly to it. All the frame and butt holes are now transferred to the plate and the moulds are removed. When the seam lap moulds, or, in the case illustrated of a sheer-strake plate, the gunwale mould for the upper edge, have been put on and the holes marked the plate is ready for punching and countersinking.

If the sheer of the ship is so bold that the variation from the straight line in the length of a plate must be taken into account, it is only necessary to use the exact sheer height at each frame in setting the frame strips, but this seldom happens.

There is now a large portion of the hull of the ship above the tank ready for erection, and it is assumed that sufficient of the water bottom, if not all of it, is completed and riveted, for a start to be made on the upper work. The water bottom or tank now forms a broad, solid foundation on which the remainder of the framing is erected, requiring no side shores whatever until the very extremities of the ship are reached. Evidently, however, as so much of the upper works have been laid out from moulds, any inequalities, however slight, in the tank must be corrected before this erection is started, otherwise bad work will result and the various pieces will not come together correctly.

For this purpose a line is leveled across the top of the center vertical keelson and marked on the inside of the bilge plates above the tank, corresponding to the line from which the side frames and belts were punched, referred to previously. The frame and belt brackets are now placed in position between the angles on the tank-top margin plates and the position of this level line transferred directly to them, and at the same time the bottom holes are marked from the angles. The bracket plates are then take to the shop and the remaining holes for the frame and belt rivets marked off from the moulds which were used for the corresponding holes in the frames and belts. As these moulds in each case are set from the level line spots referred to, it is evident that when the brackets are put back in position on the ship

and the frames and belts bolted thereto, their tops will come true to the spar-deck line independent of high or low points in the tank margin itself, and, therefore, the main-deck line, stringers, and plate edges will also come true.

The belt, stanchions, and main-deck beams are now erected by the overhead crane, leveled, plumbed, and squared up, the whole making a self-contained structure. The sheer strake is then bolted into place and the frames put up. As soon as the shifting boards, bulkheads, and main-deck stringers and ties are in place, the spar-deck heads are put in and the shell plating bolted up with the upper and lower side stringers. The spar-deck plating between hatches which had previously been punched from moulds (corresponding plates in each space being exactly alike, except for manholes, mast holes, etc.) is now put in place, as well as the channel ties and intercostals under and between the spar-deck beams, and the athwartship hatch coamings. When all bolted and reamed a large amount of work, both inside and shell, is opening up for the machine riveters. The remaining strake of side plating amidships, that immediately above the bilge, is now templeted off the ship, thus eliminating the effect of any variations in the height of the tank margin.

The above description includes about all of the ship which is gotten out by what may be called duplicate mould work. The remainder of the framing at the ends, etc., is laid out, furnaced and punched from ordinary individual wooden moulds, and the plates, stringers, etc., templeted off the work in the usual manner. No scrieve board is used.

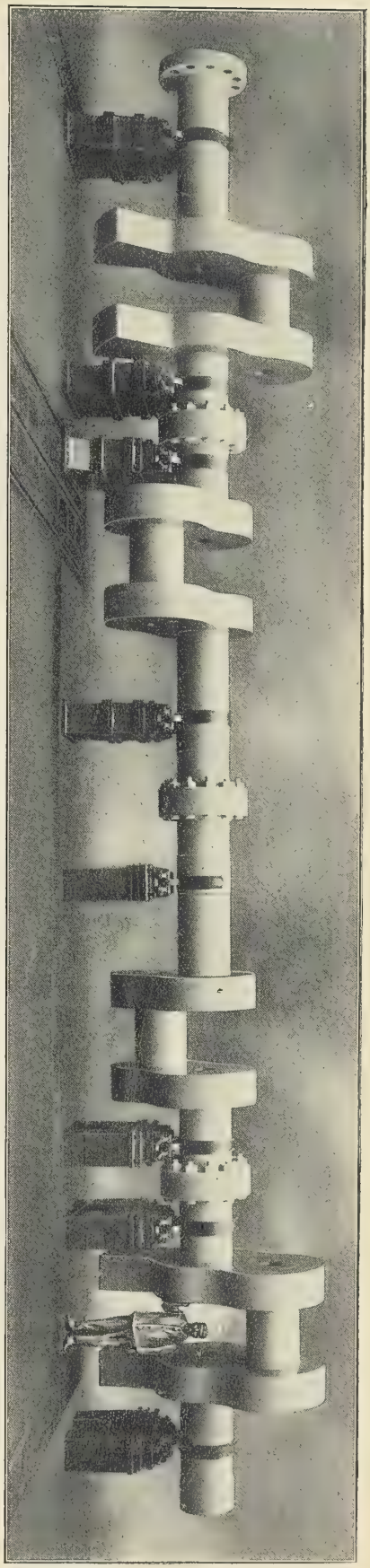
In general, it may be said that the system used in the Chicago yard requires very careful work in the mould loft, explicit directions to the foreman in charge of each ship, and a thoroughly competent and experienced superintendent in actual charge of the yard to harmonize the work of the various shop and outside foremen and to decide where duplicate work shall stop and a return be made to ordinary methods.

This is principally a matter of cost in every case. If too much time and labor is required to bring certain portions of the structure to such exact accordance with the mould-loft floor, that other portions following them, laid out from moulds, made from the floor, will go exactly into place, it is cheaper to follow ordinary methods, where a much greater variation is allowable, because each piece is based only on the piece next ahead of it, and, therefore, errors are not cumulative.

As a matter of personal opinion, however, after an experience covering the construction of some thirty ships of large size under the mould system, the writer thoroughly believes that this system is the cheapest known and can be applied to a large extent with great advantage in any yard where large ships are built, of any type.

While docking at Newport, R. I., the torpedo boat *Dupont* attempted to ram a wharf and was badly damaged forward, her bows being crushed in. A defect in the engine telegraph is said to have been the cause.

Admiral Ahmed Pacha, of the Turkish Navy, is now in this country, presumably for the purpose of placing an order for a warship here.



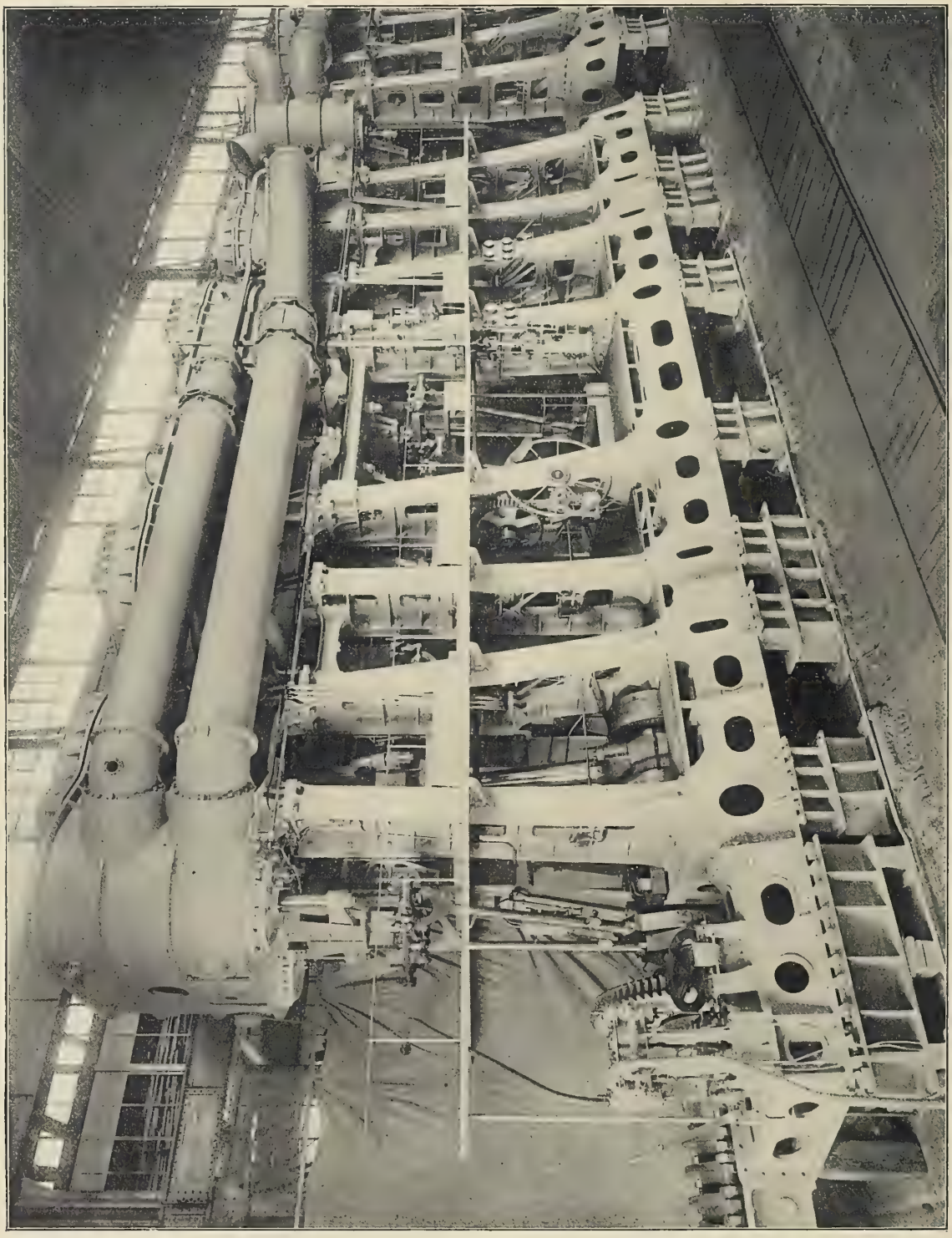
ONE OF THE NICKEL-STEEL CRANK SHAFTS OF THE NEW HAMBURG-AMERICAN LINER DEUTSCHLAND—NOTE COMPARATIVE SIZE OF MAN AT FORWARD CRANK.

Hamburg-American T. S. S. Deutschland.

Owing to an unlooked for and regrettable mishap, the Hamburg-American liner *Deutschland* did not start on her maiden voyage June 17 as had been intended. Early in the month while on her way down the River Oder, from the builder's yard at Bredow to Swinemunde, preparatory to a trial run in the Baltic, she went aground in the channel. Assistance was promptly rendered by salvage companies and by the German coast defence vessels *Aegir* and *Odin*, which were ordered to her aid. Dredges were put to work to make a channel, and increased buoy-

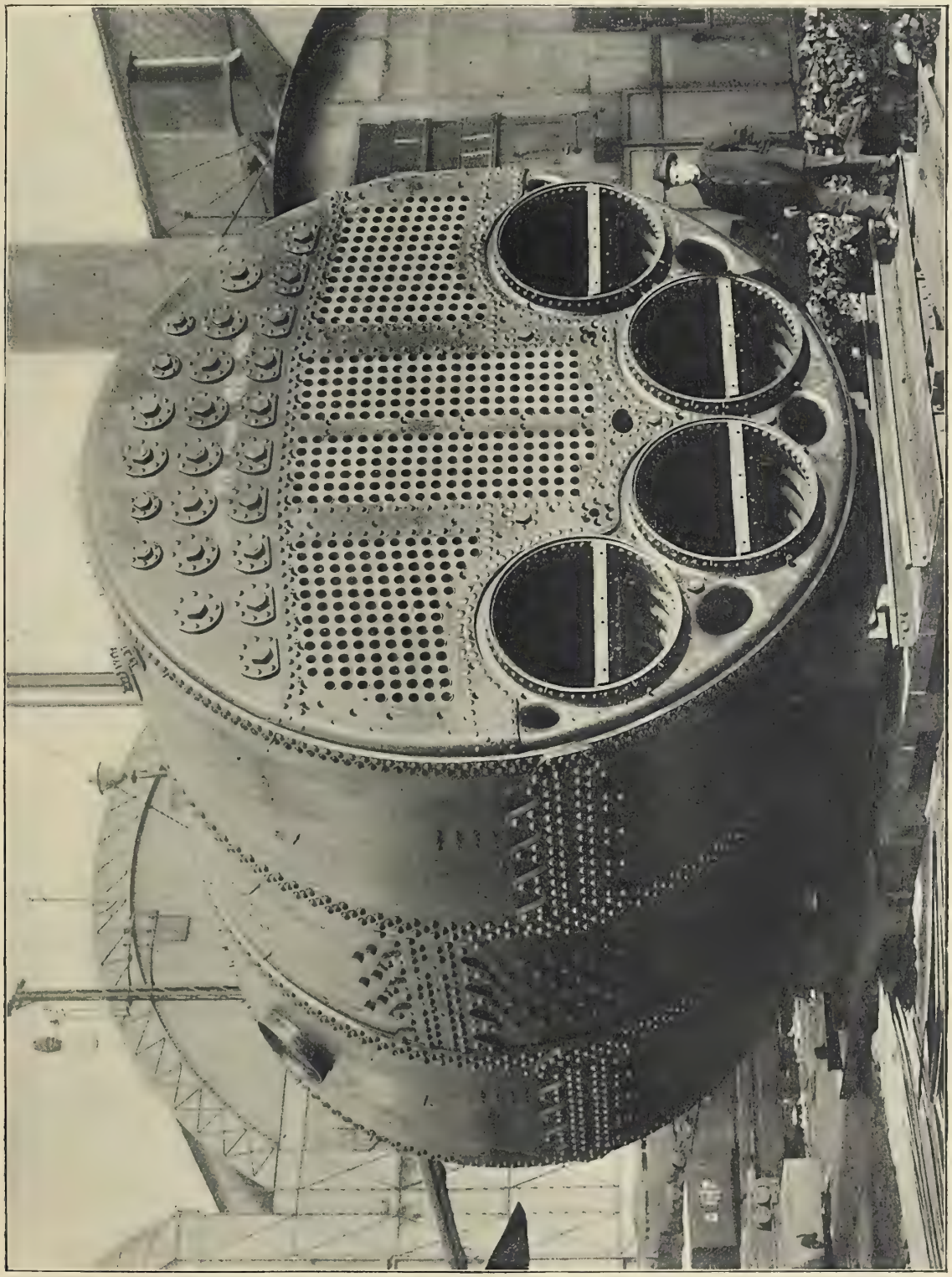
ancy was secured by the use of pontoons, so that by June 13 she was afloat again. Before reaching the sea, however, she went aground again and another delay was caused, the vessel not reaching Swinemunde until after the middle of the month. From there it was reported she would proceed to Hamburg by the outside route, being too large a vessel to go through the Kiel canal, and, all going well, would sail for New York July 5. As the bottom where the vessel grounded was chiefly mud, it is not believed that she has sustained any structural damage.

Through the courtesy of the American managers of the line we are able to here present reproductions of original photographs of the machinery of the new vessel. In our issue last month we gave the chief dimensions of the main engines. As will be recalled



SIX-CYLINDER, FOUR-CRANK QUADRUPLE EXPANSION ENGINES OF T. S. S. DEUTSCHLAND—NOTE H. P. TANDEM CYLINDERS ARE NOT IN PLACE.

they are of the six cylinder, four crank, quadruple expansion type, with the two high pressure and the two low pressure cylinders tandem in the center and the two intermediate pressure cylinders at the ends.



ONE OF THE DOUBLE-ENDED 8-FURNACE MULTI-TUBULAR RETURN TUBE BOILERS OF THE NEW TRANSATLANTIC LINER DEUTSCHLAND.

These engines—each set of about 16,500 I. H. P.—were a big job even for a large shop like the Vulcan Works, and as they were not erected in pits there was not sufficient head room under the traveling cranes in which to set up the high pressure cylinders in position. The position of the H. P. cylinders in the completed engine can be located by noting the beds for their reception on the tops of the L. P. cylinders. The photograph gives no adequate idea of their size, as there is nothing in the picture with which to make a comparison. It is usual in a case of this sort to include a man in the view, so that in this way a rough estimate

can be made of general dimensions. This result has been secured, however, in the case of both the boiler and the crank shaft, in the latter view the relative size of the man and one crank, even, gives a better idea of the immensity of these engines, though they are not as huge as engines of this power would have been in the old days of the tandem compound. Each crank shaft is hollow, in four sections, of the built up type with counterbalances on the I. P. cranks. Each is made of nickel steel and is a magnificent specimen of forging of these dimensions: length 59 ft. 3 3-8 in., outside dia., 25.2 in., length of throw 36.42 in., weight (22,330 lb.) close to 100 tons. By comparing the dimensions of the crank with those of the workman in the photograph a proper realization of its dimensions is possible, and then by mentally transferring these to the general view of the engines the actual sizes can be properly appreciated. Nickel steel is also used for the propeller shaft, and the intermediate shafting is of Siemens-Martin steel.

There are twelve double ended and four single ended Scotch boilers in the vessel contained in four separate boiler compartments. The boiler shown in the engraving is one of the double ended type, with eight furnaces. It is 16.16 ft. dia. and 20 ft. long, and the diameter of each furnace is 3.6 ft. The boilers are constructed to withstand a working pressure of 225 lb. per sq. in. The total number of fires is 112, grate surface, 2,188 sq. ft.; heating surface, 85,465 sq. ft. Howden draft is fitted.

Log of S. S. Oceanic.

A interesting feature of that most complete record of vessel movements, *The New York Maritime Register*, is the abstracts of steamships' logs published in its pages. From these we here reproduce the log of the White Star liner *Oceanic* on a recent westward trip as follows:

OCEANIC.

From Liverpool May 30, 4.34 PM left the Stage, 8.31 Rock Lt H abeam; May 31, 9.30 AM left Queenstown, 10.08 Daunts Rock lightvessel abeam.

Date.	Wind.	Lat.	Lon.	Dis.	Remarks.
May 31	Variable	51 25	9 22	45	Light Variable winds, smooth sea, fine weather
June 1	Variable	49 56	22 55	524	do do do
2	Variable	47 01	34 49	505	Gentle breeze, SW swell, fine weather
3	Variable	42 50	45 21	512	Light variable airs, heavy rain, fresh breeze, cloudy
4	SW. Var.	41 25	56 03	492	Mod. breeze, foggy, reduced speed, rain, clear weather
5	Variable	40 41	67 12	507	Light airs, smooth and clear, thence misty weather
		To Sandy Hook Lt V		303	June 6, 2.55 AM Sandy Hook Lt V abeam

The steaming time from Roches Point to Sandy Hook was 5 days 21 hours, and 47 minutes, and the course covered 2,888 knots. This is about an hour behind her best previous westward run. The speed average is 20.37 knots, and the best daily run, as shown in the log, 524 knots.

SUPERIMPOSED TURRETS.—Owing to the difference of opinion among the chiefs who form the Naval Board on Construction at Washington, as to the adoption of the superimposed turret for new battleship designs, a special investigation of the question by a board of naval officers was ordered. The result is that a compromise is proposed so that in future designs both systems of placing guns on a ship will be used. This result is highly unsatisfactory, as it is not an answer to the claims of superiority for either system.

A FEW SUGGESTIONS ON THE USE AND ABUSE OF LUBRICANTS.

BY C. GOING.

In the successful operation of modern marine machinery the judicious and economical distribution of the lubricating materials necessary to reduce the friction of the moving parts, forms an important factor. This is a subject upon which there exists as great a diversity of opinion as can be found anywhere; probably no two sea-going engineers can or will agree as to the kind of lubricants to be used, nor as to the methods of applying them. In this brief article it is the intention of the writer to dwell only upon a few points which have come under his observation. Probably the most important branch of the subject is the question of economy. The advent of the modern multiple expansion engine has caused greater attention to be paid by designers to automatic devices for distributing lubricants.

The up-to-date marine engine can, at moderate speeds, run without any oil being applied by hand, and therein lies, in my opinion, one of the greatest disadvantages of the system. While automatic lubrication is undoubtedly a necessity for fast running engines, too much dependence is placed upon this method while running at moderate speed. On Government vessels particularly, where fully nine-tenths of the cruising is at an economical speed, the consumption of oil is an important item. Relying to a great extent upon the automatic devices provided for maximum conditions, no matter how finely the feeders may be adjusted, it will be found that the quantity of oil consumed will be greatly in excess of that used by careful oilers, applying it by hand. I have an instance in mind of a vessel to which I was once attached, where the allowance of oil was ten quarts per watch of four hours, for all machinery in operation. Owing to head winds and stormy weather, which greatly reduced the speed, it was found that at the rate of using oil, the supply on hand would last only three days, whereas under the most favorable conditions it would take at least five days to reach our destination. As the existing oil allowance was considered to be as low as was consistent with safe running, this scarcity of oil became a very serious problem. After a consultation it was decided to shut off all automatic lubricators except the telescopic oilers for the crank pins. The engine room force was warned to be particularly vigilant, and to exercise the most rigid economy in the use of lubricants. As a result, the amount of oil used was reduced to just one-half the former allowance, and that, too, without a suspicion of a hot bearing. In subsequent cruising these regulations were kept up, with

the result that large quantities of oil and other lubricants were saved.

The average oiler is prone to place too much reliance upon self-feeding devices, and as a result, becomes lax in his attention to the journals. If he is compelled to oil by hand while running at moderate speeds, he will be much more vigilant at full speed, when the machinery requires, in addition to the automatic lubrication, the greatest care on the part of the attendants.

Another source of waste is the use of fluid lubricants on journals having but little motion; some of the various grease compounds will do just as well, and be far more economical. By the use of compression cups, ample lubrication can be provided for such journals as those connected with the valve gears, without resorting to the use of the squirt can. In addition to being more economical, the compound is much cleaner, as the small amount of it used can be easily wiped off.

Thrust bearings, if not properly arranged, require a large amount of oil. They should be so arranged as to run in oil and be provided with oil tight covers to prevent the oil from being thrown out by the centrifugal force. By circulating sea water through a coil in the lower part of the thrust no difficulty need be experienced in keeping the oil at a sufficiently low temperature. If the stuffing boxes at the ends are kept tight, the leakage can be reduced to a minimum.

Eccentrics, as a general thing, require a considerable amount of oil, but if they are so arranged that the lower parts of the straps dip into fresh water in the drip pans, they will be found to run cool on a greatly reduced amount of oil, as compared with those which are not kept cool by water.

The practice of automatically oiling piston rods and valve stems is a poor one, inasmuch as the lighter oils, such as are used in overhead reservoirs for the other running parts, are almost worthless on hot rods. An occasional swabbing with thick cylinder oil will, in most cases, suffice to prevent undue heating.

The recent naval practice of having one large tank as high up under the protective deck as possible, from which all reservoirs about the engine are filled, is very advantageous, not alone from the increased head obtained, but from preventing the frequent spilling which occurs while filling the reservoirs from large cans or feeders. A great saving in oil can be accomplished by the use of a good filter, wherein as much waste oil as can be caught, is, after filtering, ready to be used over again. The crank pits or drip pans should be provided each with a drain pipe leading into a small tank placed below the level of the bottom of the pits. In this way at least one-half of the oil which would otherwise go to waste can be saved.

In general, the question of economy in the use of lubricants, resolves itself into a personal equation, to a large extent. Where one oiler, by vigilance and good judgment, can keep an engine running cool, with a certain allowance of oil, another may use twice as much with no better results; however, with the adoption of economical methods, and a strict supervision of the engine room force by the engineer on watch, it is safe to say that there are but few ships where a saving could not be accomplished.

In regard to the materials used, much satisfactory advance has been made, of late, in their lubricating qualities. The present tendency seems to be to use as little of animal oils as possible. This, no doubt, is largely due to the gradual cheapening and improvement of the light mineral oils. Another excellent reason for the abolition of animal oils, especially of lard oil, is the bad stench which it creates in the engine room bilges. Animal oils are also very liable to clog up the distributing pipes, unless they are frequently cleaned out.

The lubrication of the internal surfaces of steam cylinders is a very important subject, especially on vessels that are equipped with water tube boilers. The practice on torpedo boats is to use no lubricants at all in the cylinders of the main engines. The question naturally arises, if these fast running engines can do without cylinder oil, why cannot the larger and slower running engines? If shipbuilders would have the courage to run the engines on trial without oil in the cylinders there would be no necessity of using oil thereafter. I know of several instances where large triple expansion engines have never had any oil in the cylinders, and from the appearance of the bores, have not suffered thereby. What is true of the main cylinders should apply to the cylinders of the auxiliary engines, but it frequently happens that many of them will not work well without the use of cylinder oil. This is especially so in the case of dynamo engines, which seem to require an abnormal amount of oil. It frequently happens that even on ships where no oil is used in the main engines, an examination of the boilers will show that undue amounts of oil have entered in the feed water, which can only be traced to the dynamo engine. Much of this is due to the use of the automatic sight-feed lubricators, which are in such common use. No matter how carefully the flow of oil may be regulated in such a contrivance, they are bound to inject far too much oil into the engine. If cylinder oil must be used, it should be mixed with plumbago and put in by a hand pump, and then at only such times as it is absolutely necessary.

Beeson's Marine Directory.—In enlarged form and with the contents brought down to date Beeson's Marine Directory of the Northwestern Lakes for 1900 has been issued. This is the thirteenth annual edition. Among the chief features of the work are: Lists of American steam and sailing vessels on the Lakes; lumber carriers, with capacity; record of vessels lost in 1899; record of engines and boilers of lake vessels; names and addresses of vessel owners of the Great Lakes; concise report on each of the lake ports, classified directory of firms and corporations connected with marine interests on the lakes. In addition there is a great variety of other intelligence, most of it of special value for purposes of reference. There is also a number of interesting views of lake vessels and other craft contained in the volume. It is printed on good stout paper (255 pages, 6 1-2 in. by 9 1-2 in.) and is strongly bound in cloth boards, so that it will stand considerable handling without injury. The directory is published by Harvey C. Beeson, 308 Royal Exchange Building, Chicago, Ill., and is sold for $5.00 a copy.

It is understood that the U. S. government will purchase the Spanish floating dry dock at Havana.

THE NAVAL STEAM ENGINE--ITS GRAPHICS AND ECONOMICS ILLUSTRATED—III.

BY ROBERT H. THURSTON.

As already indicated, the internal wastes, which are the most serious of all the avoidable forms of loss in the simple engine of Watt and his contemporaries, may be reduced by steam jacketing, as first practiced by that great inventor—the first to recognize their real nature—in the attempt to extinguish this form of waste, by superheating, or by compounding. In the modern engine of highest efficiency, as a rule, both compounding and jacketing are adopted, and the result is the reduction of the internal wastes very considerably. In the next diagram, Fig. 5, the method of gain by this system of multiple expansion, by placing cylinders in series, in such manner that the wastes of the smaller shall be utilized in meeting the demand for steam to supply wastes in the larger cylinders, is practically to divide this internal loss by the number of cylinders thus arranged in series. When the waste of anyone cylinder, thus added, becomes so far minimized that its addition no longer pays, either through exaggerated external and friction wastes, or because of its cost, the process of economizing ceases.

In the diagram, Fig. 5, let the costs of power, in the ideal cycle here taken as the relative standard, be represented by the lowest curve of the set, its measure being given in *B. T. U.*, on the left, and in pounds of steam per horse power per hour, on the right. The data assumed are initial pressure 125 lb. back-pressure 1.5 lb., ratios of expansion ranging from unity to thirty, condensation complete and feed-water taken from the hot-well at the condenser temperature.

Under such conditions of operation, the purely thermodynamic machine would thus demand from 40,000 to 50,000 *B. T. U.* at full stroke, down to 10,000 at fifteen and about 7,500 at thirty. Adding the friction wastes of the real engine, as found by trial of the better class of such machines, we obtain the second curve of the set, giving costs of power several per cent higher. Then adding the internal wastes and neglecting external losses as unimportant, we obtain, for the simple engine, the curve next the upper, bounding, curve of the series, as the measure of the demand for heat and steam of a simple engine of moderately large size, operated under what would be regarded as ordinarily favorable conditions, and considerably better than in the average case of engines in general use. The costs of power are here from above 45,000 *B. T. U.* at full stroke, to 20,000 as a minimum; the latter, as here found, at about a ratio of expansion of 12. At thirty expansions, the figure rises nearly to the cost of full stroke. Adding, still further, the equivalent of the operating expenses, apart from those of supplying steam, and we obtain the upper line of the diagram, showing that the total costs of power-supply become a minimum at some ratio of expansion, at some cut-off, sensibly different from that described by a comparison of "duties" and of steam and fuel and heat expenditures. This final criterion always dictates a moderate ratio of expansion and often makes the best cut-off considerably less than does the duty requirement simply. Here it reduces the ratio of expansion to about nine, instead of twelve or thirteen.

Compounding the engine, by the addition, by McNaught's system, we will say, of a high-pressure cylinder, the internal wastes are reduced by about one-half and the middle curve of the series is produced, showing a demand for heat and for steam, as a minimum, one-third less than with the simple engine and increasing the allowable ratio of expansion to sixteen. Similarly the conversion of the system into a triple-expansion arrangement, dividing the internal wastes by about three, gives makes the cost of power, measured in thermal units and in weight of steam demanded, about sixty per cent. of the figures for the simple engine, making them about 12,000 *B. T. U.* and 12 lb. of steam, as against 20,000 *B. T. U.* and 20 lb. Finally, making the machine quadruple-expansion, the figures drop to one-half their maximum, to 10,000 *B. T. U.* and 10 lb. of steam, approximately, and the available expansion becomes twenty-four for this particular case, as based upon the thermodynamic case and non-financial considerations. Taking into account the operating costs, as a whole, and constructing a new line, as in the case of the simple engine, this would make the allowable ratio of expansion more nearly fifteen or eighteen, for the triple and quadruple engines, and perhaps about twelve for the compound engine.

Naval Engines, as already remarked, are subject to quite different conditions, in design, as in operation, from the engines of mills and factories, or even from those of the mercantile marine. They will, and should, therefore, give a somewhat different distribution of the energies supplied them from their boilers and utilized, in greater or less degree, in application to the propulsion of the ship.

The following represents the method and the outcome of an attempt to ascertain what is this distribution, in the general manner previously described, in the case of a famous and successful iron-clad, of which the contract-trial figures are available. The method is that which has been employed by the writer, and his fellow investigators in office-work, for a long time, and is simply the method of Rankine, so far as it affects the ideal case, supplemented by the processes of discussion of the distinctive features of real engines, in the forms assumed by them during the years of gradual development of the complete theory of the real steam-engine and of other real heat engines, since the days of Clark's, of Hirn's, and of Isherwood's pioneer work.

The computers, in the present case, were Messrs. Austin and Howell, of Sibley College, who became sufficiently interested in this subject, and in the development of naval engineering, to undertake the investigation, submitting the final report as a part of their advanced work in this field of higher engineering.

In choosing a subject for this investigation, it seemed preferable to take an actual case, a test known to be reliable, and to work out the corresponding ideal cases, computing the various wastes by formulæ derived, as has been indicated, from previous experimentation.

The test chosen was the contract trial of the U. S. S. *Maine*, in October, 1894.[4] The data are complete, ex-

[4] The engines of the *Maine* are fully described in the *Journal of the American Society of Naval Engineers*, 1895.

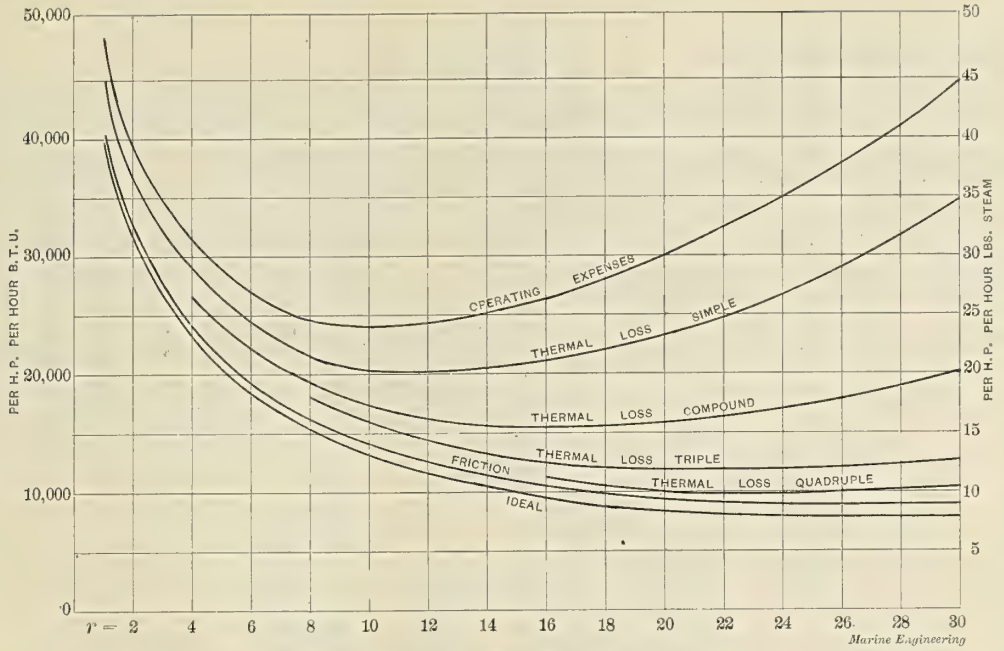
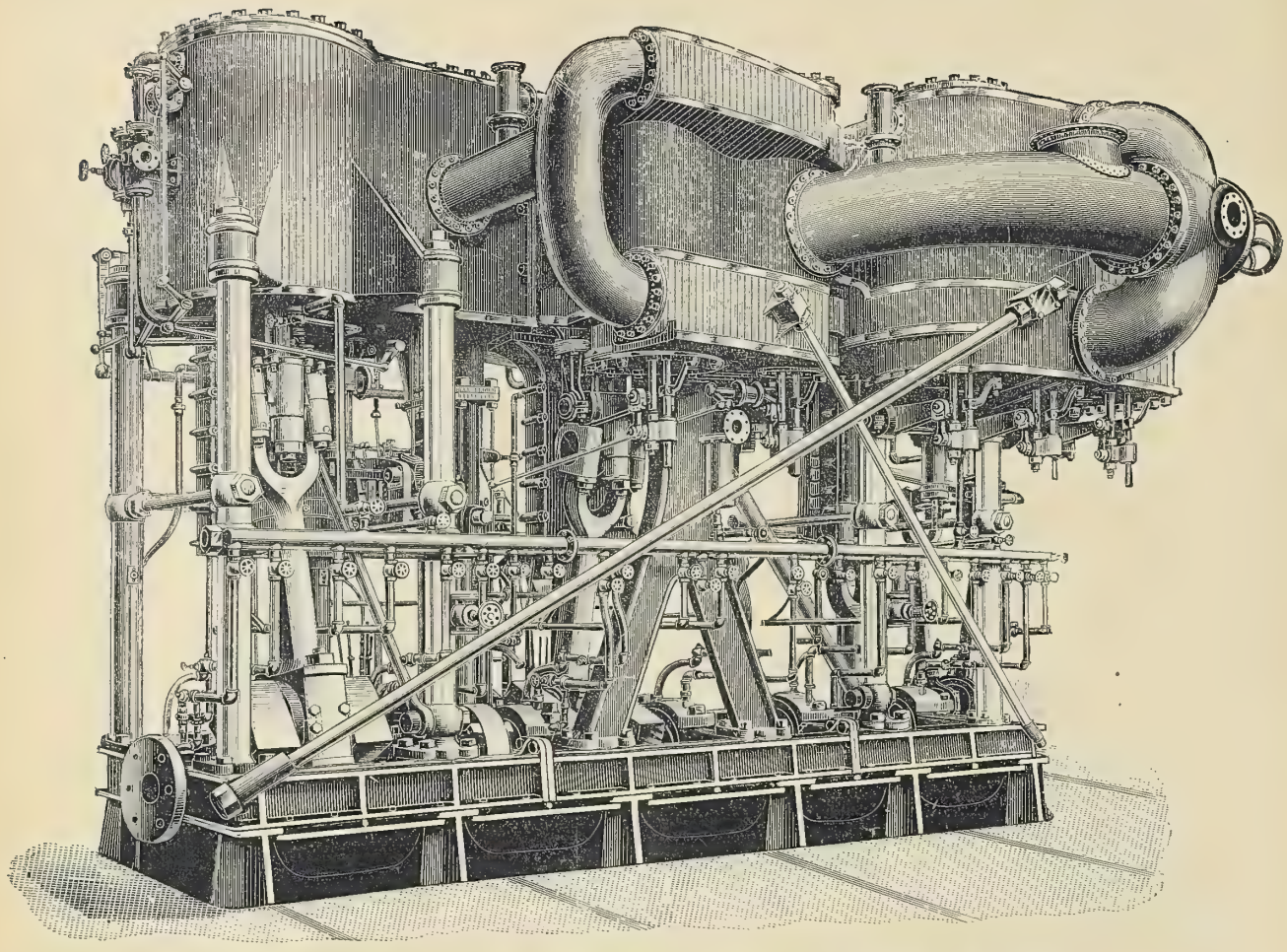


FIG. 5—EFFICIENCIES OF ENGINES (JACKETED).
$P_1 = 125$; $P_3 = 1.5$; 1,500 *H. P.*

cept in one particular: no measurement of the steam used during the test was made. To supply this deficiency it was necessary to assume an evaporation-rate. Pocahontas coal was used with forced draught, 35.3 lb. being burned per sq. ft. of grate surface per hour, and for the type of boiler in use on this vessel, with this rate of burning, an evaporation of 9 lb. of water per lb. of coal is taken to represent an excellent perform-

THE LATE U. S. S. MAINE, TRIAL DATA OF WHICH IS HERE REFERRED TO.



THREE CYLINDER THREE CRANK TRIPLE EXPANSION ENGINES OF THE LATE U. S. S. MAINE.

ance. It is probable that any error lies on the side of excess of computed over actual steam consumption.

THE PRINCIPAL DIMENSIONS and proportions of the machinery are:

TABLE III.—DIMENSIONS.

Number of cylinders (each engine)	3
Dia. of H.P. cylinder, in.	35½
I.P. cylinder, in.	57
L.P. cylinder, in.	88
Stroke of all pistons, inches	36
Dia. of H.P. valves (one for each cyl.), in.	22
I.P. valves (two for each cyl.), in.	22
L.P. valves (three for each cyl.), in.	22
Area H.P. steam port for max. opening, top, sq. in.	104.260
bottom, sq. in.	132.352
I.P. steam port for max. opening, top, sq. in.	134.576
bottom, sq. in.	260.640
L.P. steam port for max. opening, top, sq. in.	449,604
bottom, sq. in.	508.248
H.P. exhaust port for max. opening, top, sq. in.	203.
bottom, sq. in.	203.
I.P. exhaust port for max. opening, top, sq. in.	406.
bottom, sq. in.	406.
L.P. exhaust port for max. opening, top, sq. in.	609.
bottom, sq. in.	547.14
main steam pipe (12 in. dia.), sq. in.	113.1
H.P. steam pipe (13 in. dia.), sq. in.	132.7
I.P. steam pipe (20 in. dia.), sq. in.	314.2
I.P. exhaust pipe, to condenser (16 in. dia.), sq. in.	201.06
L.P. exhaust pipe (28 in. dia.), sq. in.	615.75
Volume swept by H.P. piston per stroke, mean cu. ft.	20.30
Volume swept by I.P. piston per stroke, mean, cu. ft.	52.84
L.P. piston per stroke, mean, cu. ft.	126.39
Clearance, in cu. ft., H.P. cyl., top	4.974
bottom	4.744
I.P. cyl., top	10.161
bottom	9.094
L.P. cyl., top	22.376
bottom	17 344
Clearance, per cent., H.P. cyl., top	24.12
bottom	23.74
I.P. cyl., top	19.113
bottom	17.314
L.P. cyl., top	17.65
bottom	13.76
Ratio of net area of H.P. to I.P. pistons	1 to 2.578
I.P. to L.P. pistons	1 to 2.383
H.P. to L.P. pistons	1 to 6.144
Dia. of piston rods, in.	6¼
Length of connecting rods between centers, in.	73¾
Dia. of connecting rods, in.	6½ and 10

OFFICIAL TRIAL.[5]

The official trial for horse power took place on the 17th of October, 1894, in Long Island Sound. The *Maine* left her anchorage off New London Light at 12 meridian, and proceeded out through the Race, and when off Watch Hill was turned and headed to the westward in order to make as nearly as practicable a straightaway run for the four consecutive hours' trial required by the contract.

The trial began at 1.30 P. M., and ended at 5.30. The weather conditions were not very favorable, for throughout the entire run the ship was steaming against a strong head wind and sea, which increased in force to the end of the trial. The ship was remarkably steady, and at the maximum speed of the engines very little vibration was noticeable.

The speed was very accurately obtained for a portion of the trial, while running over the official measured

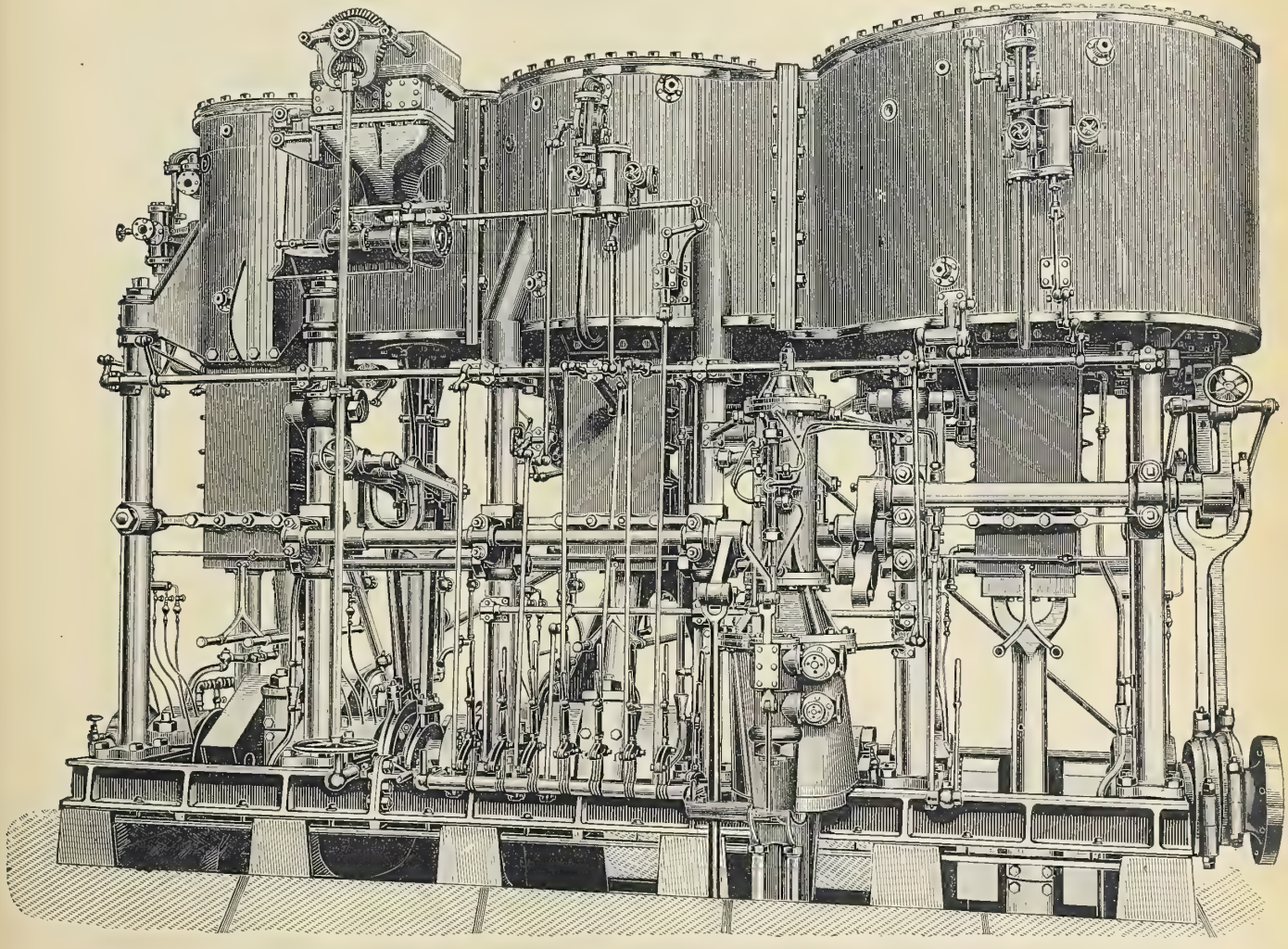
[5] From the official report.

course laid down for the trial of the *Ericsson*. The average speed for this 25-mile course was 15.95 knots, and with a mean allowance of 1.5 knots for the strong head wind and tide, the average speed of the ship was 17.45 knots.

TABLE IV.

DATA OF OFFICIAL TRIAL, U. S. S. "MAINE."

Draught of water at beginning, forward, ft. and in.		18— 2
aft., ft. and in.		19— 1
at end, forward, ft. and in.		17—10
aft, ft. and in.		18—11
mean, for trial, forward, ft. and in.		18— 0
aft., ft. and in.		19— 0
Disp. at mean draught on trial, tons		5,500
Area of mid. section at 18 ft. 6 in. mean draught, sq. ft.		906
Wetted surface, sq. ft.		21,850
I.H.P. (total) per 100 sq. ft. of wetted surface		42.53
I.H.P. per 100 sq. ft. of wetted surface at 10 knots in ratio of 3.5 power		6.0142
Mean speed, knots		17.45
Slip of screws, mean, per cent, starboard		12.805
port		10.205
$Speed^3 \times$ area immersed midship section $\div$ I.H.P.		518.26
$Speed^3 \times displacement^{\frac{2}{3}} \div$ I.H.P.		165.21
Synopsis of Steam Log.	*Starboard.*	*Port.*
Revolutions of main engines per min., mean	125.96	122.313
Piston speed, ft. per min.	755.76	733.878
Steam at boilers, gauge	144.9	
engines, gauge	136.27	134.63
first receiver, absolute	67.70	66.33
second receiver, absolute	28.84	34.34
Vacuum in condenser, in. of mercury	23.875	22.839
Opening of throttle, tenths	10.	
Steam cut off in fraction of stroke from beginning, H.P.	.8	.8
Steam cut off in fraction of stroke from beginning, I.P.	.7	.7
L.P.	.7	.7
Double strokes of combined air and circulating pumps	51.55	42.444
	Starboard.	*Port.*
Temp. in deg. Fahr., steam at H.P. cyl.	364.0	363.4
Temp. in deg. Fahr., injection	63.	
discharge	114.	99.5
hot well	127.3	127.3
feed	127.3	127.3
engine rooms, upper	146.	
lower	99.	
fire rooms, forward	127.	
after	134.	
Revolutions of blower per min., main boilers	450.	
Air pressure in in. of water, ash pits	1.074	
furnaces	.92	
H.P. cyl., mean pressure	54.372	53.656
I.H.P.	1,216.89	1,165.56
I.P. cyl., mean pressure	20.907	19.597
I.H.P.	1,218.35	1,108.94
L.P. cyl., mean pressure	16.236	16.267
I.H.P.	2,261.75	2,200.00
Aggregate equivalent mean pressure on L.P. piston	33.7175	33.0855
I.H.P. collective of each main engine	4,696.95	4,474.50
of both main engines	9,171.45	
of combined air and circulating pumps	28.25	24.593
collective of air and circulating pumps (2)	52.843	
of all forced draft-blowers (4)	38.068	
of main feed pumps (2)	15.429	
of other auxiliaries	14.856	
of all auxiliaries	121.1962	
each main engine, air and circulating pump	4,725.20	4,499.093
both main engines, air and circulating pumps	9,224.293	



THREE CYLINDER THREE CRANK TRIPLE EXPANSION ENGINES OF THE LATE U. S. S. MAINE.

I. H. P. total of all machinery in use....	9,292.646	
Indicated thrust (I.H.P. main engines).	57,354.40	
per sq. in. of surface of thrust bearings..	59.31	
Cu. ft. swept per min. by L.P. piston, per I.H.P. of main engines.....	6.73	6.87
Sq. ft. of H.S. per I.H.P.....	2.0462	
of cooling surface per I.H.P.....	1.5087	
I.H.P. of all machinery in operation, per sq. ft. of G.S.....	16.1938	
I.H.P. per ton of propelling machinery, boilers and water	14.18	
Coal Consumption.		
Sq. ft. of G.S. in use.....		573.84
H.S. in use		19,015.36
Kind and quality of coal used.....Pocahontas, good quality.		
Coal burned per hour, actual weight, lbs.....		20,272.
per sq. ft. of G.S., lbs.....		35.327
H.S., lbs.....		1.066
per I.H.P. of all machinery, lbs.		2.1815
per I.H.P. of main engines, air and circulating pumps, and feed pumps, lbs.		2.194

(To be continued.)

German Torpedo Boats.

There was recently launched at the Schichau shipyard at Elbing, the one hundredth torpedo boat constructed for the German Navy. The launching was a ceremonious occasion, and it was the subject of much comment in the German press. As showing the German view of such matters, we here publish a translation of an article on the event from one of the leading German journals, as follows:

Torpedo boats are divided into two classes—pole torpedo boats and fish torpedo boats. The first-named variety first demonstrated their utility in the American war of the rebellion. In those days the boats were very small and were called "Davids" after the Jewish king. The boat had a pole 30 ft. long attached to the bow, and a torpedo was placed at the forward end of this and was exploded by contact with the enemy's vessel. During the above mentioned war the most notable event in the use of this type of boat was the attack which was made by Lieut. Cushing on the Confederate armored vessel *Albemarle*, Oct. 27, 1864, at three o'clock in the morning in the Roanoke River. The explosion of the torpedo tore a large hole in the *Albemarle* close to the water line, and she sank in a few minutes, but the torpedo boat was swamped by the column of water which was thrown up by the explosion.

In the Turko-Russian war of 1877-78 two Turkish monitors were destroyed on the Danube River by a night attack of Russian pole torpedo boats.

The first large torpedo boats were the armored American boat *Spuyten Duyvel*, built in 1865, and the English boat *Vesuvius*, both with a speed of 10 knots, and the German boat *Ulan*, all fitted with pole torpedoes. At the time of the Franco-Prussian war the German Navy had a number of pole torpedo boats, which had a speed of only 8 knots and which were not brought into play at all. The first practical boats of both types were built at the English yard of Thornycrofts. In Germany the Schichau yard at Ebling had already built quite a number of boats for the Russian Navy since 1877, when the German Admiralty made a comparative test of the boats of all the well known builders. The superiority of the Schichau type as developed by their constructor, Mr. Tiese, was so pronounced that even in the British Navy it was given precedence under the name of "German type." These torpedo boats were mostly 115 to 150 ft. long, with a draft of about 6 1-2 ft., and a displacement of 85 to 144 tons, and were built of steel, combining strength and lightness. The crew of one of the 90-ton torpedo boats consisted usually of one naval officer as commander, one chief engineer, two junior officers, three assistant engineers, four sailors and four firemen.

The adopted system in Germany at present consists of a rather large type of boats, very seaworthy and having a large radius of action and all built with a certain uniformity to each other. Other navies have, in addition to this class, a large number of smaller boats, with small radius of action, and which can only be used at local points for coast defense. In 1897 a torpedo boat called the *Turbinia* was tested in England. This boat was fitted with Parson's turbines instead of the usual reciprocating engines. It was believed at that time that Thornycroft had put Schichau out of the field with this boat, but this has not materialized.

If at times one or two trial boats were occasionally ordered elsewhere, the German Navy has always returned to Schichau. The German torpedo boat fleet stands as a model to the whole world, and this is amply demonstrated by the numerous orders received by Schichau from foreign nations. Up to the present time the Schichau yards have turned out 265 torpedo boats, of which 100 were for the German Navy. Altogether 674 vessels were launched at this yard.

The new torpedo boat S100 belongs to the new series S90 to S101, of which the first boat has made all its trial trips very successfully and has proven itself seaworthy. The principal dimensions are as follows: Length, 200 ft.; beam, 23 1-2 ft.; draft, 8 1-2 ft.: displacement, fully equipped, 350 tons. The average speed is 26 knots in a long run. The twin triple expansion engines develop 6,000 I. H. P. The shop number of the engines is 1878-79, and of the boilers 2168-70. These may be simple figures, but to the initiated they represent an enormous amount of work, experience and success in ship and engine building, which no other concern in the world can approach.

We wish the jubilee torpedo boat S100 all the success and hope that it may bring honors to its builders and satisfaction to the greatest of War Lords, His Majesty, the German Emperor.

It will be noticed that, contrary to the usual European attitude, proper credit is given to the United States for the origin and early development of the torpedo boat, which, though crude when compared with present practice, was effective in its way, and like our monitor, was the cause of many subsequent radical changes in naval construction the world over. The little sketch of torpedo work written by our German contemporary is very fragmentary and does not cover all the exploits of the torpedo. We have not attempted to embellish it, but to present it to our readers as originally written. The author, however, is not up-to-date on the developments in turbine driven torpedo vessels, as the *Turbina* is now a back number when compared with the *Viper* and *Cobra*, which have been reeling off about 35 knots lately on trial. It is interesting, also, to note that there is nothing small about the claims of our contemporary as to the superiority of the German boats. We believe the United States have been often criticized abroad for the frequent use of superlatives, but apparently we have not a monopoly in this special field of mental activity. The reference to Emperor William represents also an interesting national view which would not, perhaps, find unqualified endorsement on other than German soil.

LAUNCHES—HOME AND FOREIGN.

S. S. LAFAYETTE.—The S. S. *Lafayette,* for the Pittsburg Steamship Co., was launched at the Lorain, Ohio, shipyard, May 31. Instead of the usual bottle of wine being broken upon the christening of the vessel, the Japanese custom of releasing a basket of doves was adopted, this ceremony being performed by Miss Harriet Lauder, daughter of George Lauder, managing director of the Carnegie Steel Co. The vessel is a sister ship to the others for the same company named after well-known institutions of learning, the *Princeton, Cornell, Harvard* and *Renssalaer.* The vessel is of these dimensions: Length over all, 474 ft.; beam, 50 ft.; depth, 28 1-2 ft. She is designed to carry 7,200 gross tons of ore on 18 ft. draft. Her engines, of nearly 2,000 horse power, are of the quadruple expansion type of these dimensions: 18 in., 26.34 in., 41 in., and 63 in. dia., and 42 in. stroke. Steam will be generated in water-tube boilers of the Babcock & Wilcox type.

S. S. JAMES S. WHITNEY.—The steel single screw freight steamship *James S. Whitney,* for the Metropolitan Steamship Co., of New York, was launched June 4, at the Harlan & Hollingsworth yard at Wilmington, Del. The vessel was christened by Miss Ruth Whitney, daughter of the president of the line. The vessel is of these dimensions: Length over all, 288 ft. 9 in.; beam, 43 ft.; depth to awning deck, 29 ft. She is fitted with six water tight bulkheads, four hatches and eight side ports. The engines are of the triple expansion type with cylinders 29 in., 46 in. and 75 in. dia., and 46 in. stroke. Steam is supplied by four return tube boilers 13 ft. long by 14 ft. dia., built for a working pressure of 175 lb. The deck houses are of lumber, with accommodations for twenty-one sailors and firemen and twenty-three officers and passengers.

S. S. ALFRED MITCHELL.—The wooden freight steamer *Alfred Mitchell,* 2,800 tons, was launched from the yard of Simon Langill at St. Clair, Mich., last month.

S. S. MONTREAL.—There was recently launched from the yard of Swan & Hunter, on the east coast of England, a large twin screw vessel for the Atlantic trade of Elder, Dempster & Co. The vessel is named the *Montreal,* and is of these dimensions: Length, 470 ft.; beam, 56 ft.; depth, 42 ft. 9 in. She is built to conform to Lloyds' highest 3-deck class. Special provision is made for carrying beef on the hoof, the vessel having room for 750 head. The machinery will consist of twin triple expansion engines, with cylinders 22 in., 37 in., and 61 in. dia., by 48 in. stroke. The deadweight capacity of the new vessel is about 10,600 tons, and she will have a sea speed of about 12 knots.

FERRYBOAT JOHN ENGLIS.—The steel hull of the ferryboat *John Englis,* for service in the East River, New York, was launched at the Marvel shipyard at Newburg, N. Y., on Saturday, June 16. The vessel is of these dimensions: Length over all, 193 ft.; beam molded, 37 ft.; beam over guards, 62 ft. 6 in.; depth molded, 14 ft. 9 in. She will be fitted with her machinery at the yard of the W. & A. Fletcher Co., Hoboken, N. J. The engine will be of the beam type with single cylinder 50 in. dia. and 10 ft. stroke, built for a working pressure of 55 lb. of steam. The wheels will be of the radial type, 21 ft. 3 in. dia., with buckets 8 ft. 6 in. long.

LAUNCH OF THE ONE HUNDREDTH TORPEDO BOAT BUILT BY HERR SCHICHAU FOR GERMAN NAVY.—See Page 300.

S. S. A. B. WOLVIN.—At the Globe Yard, Cleveland, Ohio, June 9, the S. S. *A. B. Wolvin* was launched. Mrs. H. G. Dalton performed the ceremony of christening the vessel. The vessel is of the full Welland Canal size, of these dimensions: Length, 256 ft.; beam, 42 ft.; depth molded, 26 ft. On a Welland Canal draft of 14 ft. the vessel will carry 2,100 tons, and on an 18 ft. draft she will carry 3,600 tons. The machinery will be of the quadruple expansion type, with engines of 1,200 I. H. P. and Babcock & Wilcox boilers.

S. Y. WATURUS.—At Leith, Scotland, the steam yacht *Waturus,* for the Archduke Stefan, of Austria, was launched recently. This pleasure vessel, which will

be very luxuriously fitted up, is of these dimensions: Length over all, 217 ft.; beam molded, 27 ft. 6 in.; depth molded to main deck, 16 ft. 2 in. She will have a single screw driven by triple expansion engines with cylinders 18 in., 28 in. and 49 in. dia., and 33 in. stroke, taking steam at 180 lb. pressure. She is built to conform to Lloyds' rules.

S. S. Ontarian.—A new cattle carrying steamer for the Allan line in the Atlantic trade was launched in May at Port Glasgow, Scotland. This vessel was built under the rules of the British Corporation and was christened the *Ontarian*. Her dimensions are: Length, 385 ft.; beam, 48 ft. 6 in.; depth, 29 ft. 6 in., and deadweight capacity about 7,000 tons. Her engines have cylinders 27 in., 43 in., and 72 in., by 48 in.

S. S. Sierra.—The first of the three steamships ordered by the Oceanic Steamship Co. was launched at Cramp's shipyard, May 29. This vessel is named the *Sierra*, and will be put into service on the Pacific on the Oceanic Company's route between San Francisco and Australia, touching at Hawaii. The S. S. *Sierra* is of these dimensions: Length, 400 ft.; beam, 50 ft.; depth, 36 ft.; displacement, 7,000 tons.

S. S. Ottawa.—At the Bertram Shipyard, in Toronto, Ont., the S. S. *Ottawa* was launched, May 23. This vessel is of Welland Canal size, package freighter, of the following dimensions: Length, 257 ft.; beam, 43 ft.; depth, 25.6 ft. She will carry 7,000 bushels of wheat on a canal draft of 14 ft., and in deep water she will carry about 100,000 bushels.

Tow Barge Bryn Mawr.—At the South Chicago Shipyard, South Chicago, Ill., the steel tow barge *Bryn Mawr*, for the Pittsburg Steamship Co., was launched June 12. She is of these dimensions: Length over all, 414 ft.; beam, 50 ft.; depth, 27 ft. She will carry 5,900 gross tons of ore on a draft of 18 ft.

Barge Indiana.—The four masted barge *Indiana* for the Coastwise Steamship Co., of New York, was launched at the New England yard, Bath, Me., June 2. Her dimensions are: Length, 237 ft.; beam, 43 ft.; depth, 20.5 ft.; capacity, 3,000 tons.

S. S. Harvard.—The lake S. S. *Harvard*, for the Pittsburg Steamship Co. (Carnegie Steel interests) was launched into the Detroit River at the Wyandotte yard on May 21. The *Harvard* is 476 ft. long over all, with a capacity of 8,000 gross tons.

S. Y. Kittewan.—At Weller Bros. yard, Trenton, N. J., the S. Y. *Kittewan*, for S. P. Wetherill, of Philadelphia, was launched last month. The yacht is a wooden vessel measuring 108 ft. over all, 16 ft. beam and 9 ft. hull.

Lengthening S. S. Indian.—Cutting a steamship in two and putting in new work to increase her length has become a familiar job now in practical marine construction. A very successful example of this was carried out lately at the Harlan & Hollingsworth yard, Wilmington, Del., when the S. S. *Indian* was cut and the ends pulled apart a distance of 40 ft. for the purpose of increasing her length by that much. After all the rivets had been cut at the forward end, which was carried on special cradles in dry dock, she was pulled out the required distance in about seventy-five minutes. The portion moved weighed about 350 tons.

PAINTS AND VARNISHES USED FOR THE PRESERVATION OF METALLIC SURFACES—II.*

BY PROF. A. H. SABIN.

There yet remains to be described one other important pigment—red lead. This is entitled to be placed in a class by itself, because it is intermediate between the paints which it resembles in being used mixed with oil, and the cements, which it resembles in its process of solidification. It is, in fact, a powerfully basic substance, and combines chemically with the oil, forming an insoluble, hard, tenacious mass, in which the uncombined particles of the excess of lead oxide are imprisoned. This is what constitutes the protective film when a red lead paint is dry. Red lead is said by chemists to be a mixture of the peroxide and the protoxide of lead, the latter ingredient being the substance known as litharge. The peroxide is believed to be the characteristic ingredient. Red lead is made by a fire process in a suitably constructed furnace, and furnaces of different construction, or even of the same plan but of different dimensions, are said to give different products. At all events, it is well known that commercially pure red lead, composed of nothing but lead and oxygen, contains the peroxide in proportions ranging from 45 to 90 per cent. The correct proportions of peroxide and protoxide for making the best protective film are not known. Doubtless much of the uncertainty attaching to the use of red lead is due to this.

Linseed oil, made from flaxseed, is the liquid part of ordinary oil paints. It is sometimes obtained by treating the seed with naphtha, thus dissolving out the oil, which is separated by distilling off the solvent for use again. Comparatively little oil is made in this way, most of it being made by extraction under pressure. The seed is coarsely ground, is then heated, sometimes by running a jet of live steam into the meal, sometimes by putting the meal into a steam-heated vessel; it is then, by a machine, put into bags and pressed enough to make it take a suitable form, after which these bags are put into a powerful press and the oil is squeezed out. Moisture and other matters are of course mixed with the oil, and these are separated by allowing it to settle; it is at last filtered. This process of purification takes from one to three months, but even after this the oil improves for a long time by standing, during which some foreign matters separate and settle out.

Linseed oil possesses, in a higher degree than any other oil, the property of thickening rapidly on exposure to the air. This is not due to evaporation, but the contrary; it absorbs and combines with oxygen from the air, and thus actually increases in weight, though it decreases in bulk. A paint made with raw linseed oil alone will dry so that it may be handled in five or six days, but, as this is a long time, it is thought necessary to treat the oil so that it may dry more quickly; that is, may absorb oxygen more rapidly. Oil so treated is called "boiled oil." It used to be made by heating the oil over a direct fire in a kettle, and with this oil is mixed, by constant stirring, 1 to 3 per cent. of oxide of lead, either litharge or red lead, or both, and a small proportion of oxide of manganese. When the oil reaches

* From a paper read before the Boston Society of Civil Engineers, and contained in the Journal of the Association of Engineering Societies, U. S. A.

a temperature of about 500° F. it dissolves these metallic oxides, entering into chemical combination with them; and, as these have a great attraction for oxygen, the resulting oil, which is much darker in color than it was, has also greatly increased drying powers, and paint made with it will dry in twenty-four hours. The dark color is due partly to the combined metallic substances and partly to heating the oil for a long time.

It is believed that much more oil is present than can possibly combine with the small amount of metallic oxides, and that the product is therefore composed of a small portion of oil combined with the lead and manganese, dissolved in a large portion of oil, which is unchanged except that it has been darkened by heat. It has, therefore, become the custom of oil manufacturers to cook only a small portion of oil with the lead and manganese, and after these are dissolved they stir the product into a large quantity of raw oil at a heat about that of boiling water. The boiled oil thus made is much paler in color than that made in the old way, and is said to be quite as good in every respect. It probably is fully as good, and very likely better, being more nearly uniform. But oil made in this way varies according to the amount of oxides used, the proportionate parts of lead and manganese and the heat employed, so that boiled oil from different makers is always different; varying much more than raw oil does.

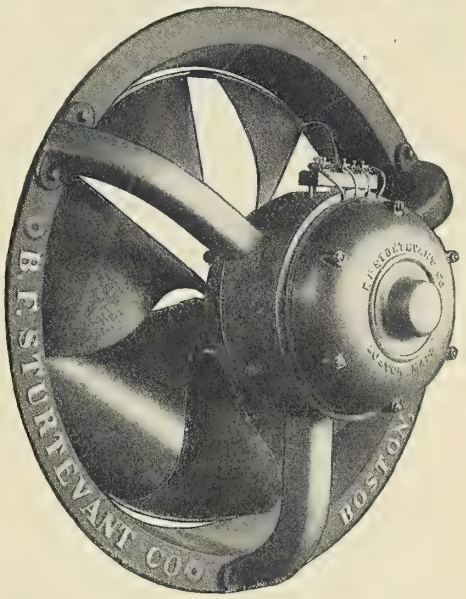
The foregoing method is the one used by the large manufacturers, but the smaller ones frequently, perhaps it may be said commonly, buy their oxides of lead and manganese already combined with just enough oil to make a compound; about four pounds of oxide of lead will combine with a gallon of oil, but the product in this case will be a solid cake. In order to liquefy this it is common to dissolve it in about two and a half gallons of turpentine or benzine (or a mixture of the two), and this solution, which is a good example of what is called a "drier," and which measures less than four gallons, contains enough metallic compound to go into about fifty gallons of oil—the contents of a barrel. So the small manufacturer or dealer opens a barrel of raw oil, takes out four or five gallons, fills it up with this drier, which he has purchased from some one who makes a specialty of it, closes the barrel, and, after rolling it about a little to mix it, sells it for boiled oil. Such oil is said to be boiled through the bunghole, and is spoken of disrespectfully by the large manufacturers; but those who follow this practice claim that such oil is in every way equal to that made in a kettle.

COMMENCEMENT AT WEBB'S ACADEMY.—Commencement exercises were held last month at Webb's Academy and Home for Shipbuilders, at Fordham, New York City, at which Andrew H. Green delivered an address on the life work of the late William H. Webb, founder of the institution. In his address Mr. Green referred to the splendid products of the Webb yard in New York in the earlier days of steam navigation. Not only were steam vessels for coastwise and ocean trade put out, but war vessels, which in point of equipment and speed far excelled those of the time. Among such were the *General Admiral* for Russia, and the *Dunderberg*, originally constructed for the United States Navy, but afterward sold to France. A dozen members of the graduating class received the diploma of the Academy.

IMPROVED APPARATUS.

Electric Ventilating Fan.

The electric disc fan has become established as a local cooling device for summer use, but its ability is limited to merely stirring up a breeze. For the actual movement of air to or from buildings or through ducts a different type is required. The B. F. Sturtevant Co., of Boston, Mass., is now building a type of electric propeller ventilating fan such as is shown in the accompanying illustration which meets the latter requirements. The fan wheel is carefully designed to act against reasonable resistance and to move the air in lines parallel to the axis of the shaft. It is contained within a special circular frame casing which is conoidal in its form as it approaches the circumference of the wheel. This results in decreasing the resistance offered to the entering air. The frame carries a tripod support with annular centre within which is accurately placed and



ELECTRIC VENTILATING FAN.

centered a bi-polar motor, consisting of a circular field ring to which the pole pieces are attached. Extending out from either side of the field ring is a yoke which contains the ring oiler bearings. The bearings are self-aligning and self-oiling, and fitted with composition sleeves, which are removable from the outer end of the boxes. Special light end casings with removable centers are provided, which when applied and bolted in place entirely enclose the motor, thereby protecting it from dust.

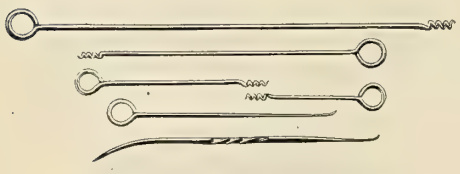
Set of Packing Tools.

A neat set of packing tools for engine room use is shown on page 304. They are made from tool steel, and are warranted not to bend or break when used in removing packing from stuffing boxes of main engines or auxiliaries. In cases of emergency, where work has to be done in a hurry, a set of these tools will be found to be a great convenience. They are manufactured by the Mound Tool & Scraper Co., St. Louis, Mo.

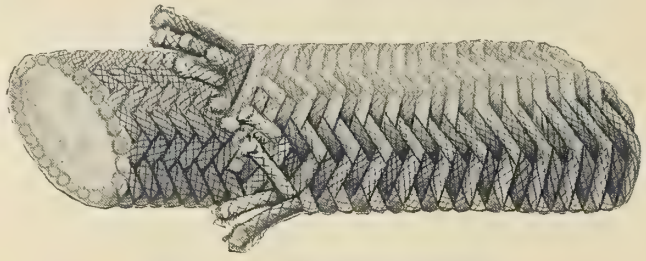
Semibronze Packing.

The engraving of semibronze packing which is presented herewith gives a good idea of the construction

and general appearance of this well known packing. As the name implies it is a combination packing combining advantages of both metallic and fibrous packings. The core, which is the foundation of the packing, is a lubricator reservoir, being composed of loosely spun asbestos thoroughly saturated with high grade cylinder oil and coated with pure foliated graphite. The covering over the core is composed of alternate strands of asbestos and flax all loosely spun and each braided over with an open net work of very fine semibronze wire. It is claimed the combination possesses the points that go



MOUND T. & S. CO. PACKING TOOLS.

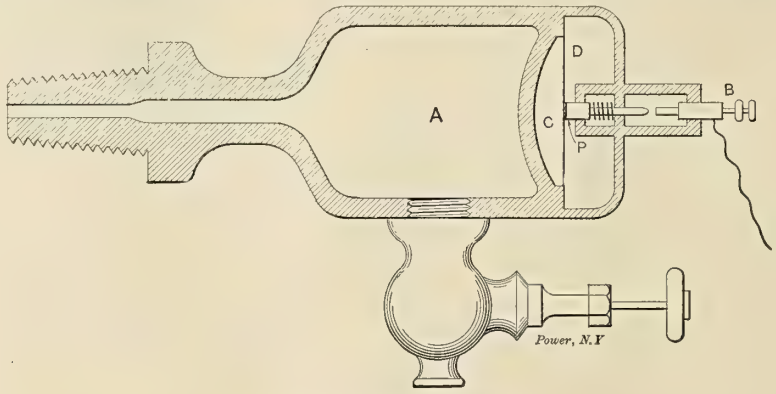


CHARLESTON SEMI-BRONZE PACKING.

to make a very durable packing for piston rods, as it is self-lubricating and has a metallic covering that protects the fibers of asbestos and flax from being blown out of the stuffing box by the steam or water pressure, and the net work of fine wire being quite open allows the lubricator to flow readily to the piston rod. Among the advantages claimed for semibronze packing are, that it will not scratch or groove the piston rods, that it requires no special care or attention in use, and that it is practically frictionless. Semibronze packing is now being used by many steamship and railway lines, by the U. S. Government in several branches of the service, and also by some of the largest mills and manufacturing concerns in the country. It is handled by the principal supply dealers, and is manufactured by the Charleston Metallic Packing Co., Charleston, S. C., which has a branch office at 32 Oliver street, Boston, Mass., to which address requests for samples should be sent.

Electric Alarm Try Cock.

A device for sounding a low water alarm has been brought out under the name of the Mathews electrical alarm try cock. A section view of this is here shown. The patent try cock is screwed into the water column or boiler in place of the lower gauge cock. Under normal conditions the water passes through the shank into the chamber *A* and fills this, thereby breaking the electric circuit. Should the water fall below the level of the cock the chamber would be filled with steam, which, by raising the temperature of the air in the chamber *C*, would cause it to expand and force out the *diaphragm D* against the plunger *P*. This in turn would come into contact with the binding post *B*, and by closing the electric circuit cause an alarm to be sounded at any distant point where it was located. If need be, more than one alarm can be operated simultaneously, say one in the fire room, one in the engine room, and one in the chief engineer's office. Where a group of boilers is in operation an annunciator is added, so that the particular boiler needing attention can be located. The circuit will remain closed until water again fills the chamber *A*, when the air in chamber *C* cooling down will allow the diaphragm to come back to its normal position. The spring on the plunger *P* will then act and break the contact with the binder post, thus opening the circuit. Suitable switches can be placed in circuit so that the alarm bell can be cut out after it starts ringing until such time as the contact is automatically broken again in the try cock. The try cock is supplied with bell, batteries, etc., ready for immediate connection. It is manufactured by the Electric Boiler Protection Co., 39 Cortlandt street, New York.

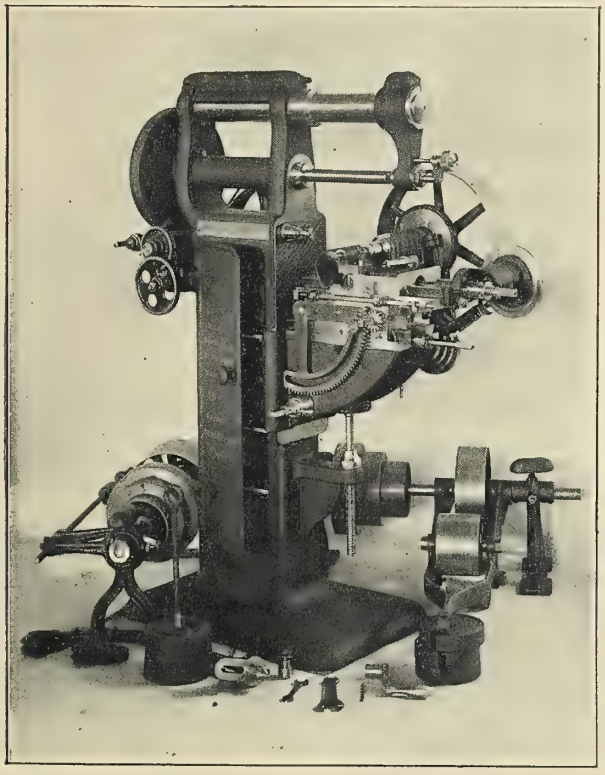


ELECTRIC ALARM TRY COCK.

Gear Cutting Machine.

In the engraving the Becker-Brainard 18 in. automatic gear cutting machine is shown, with countershafts. This machine is adapted for cutting spur, bevel, and worm wheels, and is automatic in all its movements. All the details are most carefully worked out. The dividing

wheel is finished with microscopic accuracy, and it is actuated by a steel worm with compensating devices for maintaining the original accuracy. It is protected by a close fitting shield, and the worm runs in an oil box. Among the features to facilitate accurate work are the centering device, which fixes the exact center of the cutter without reference to the position of the knee or other parts; the dial reading to thousandths of an inch, connected with the elevating screw and permitting the setting of the cutter to the correct depth without the use of separate depth gauges; also possible special adjustments of the cutter carriage for setting it at various angles. The automatic feed is arranged so that the feed cones and feed belt run always in one direction though feeding both ways as needed. The cutter spindle has a long taper center hole to receive the cutter, allowing a wide range of sizes to be used. It is also provided with an outer center support giving great steadiness in working. To admit of ready disconnection of the automatic devices, for examination of the work or operating the machine by hand, a radial clutch is placed on the feed screws. In the body of the machine the change gears are conveniently placed in a wooden case. With each machine an overhanging removable arm and a center with dog attached are supplied, and if desired a rack cutting attachment can be furnished. The maximum size of work which this machine will handle is: Diameter of cut, 18 in.; width of face, 4 in.; length of feed,

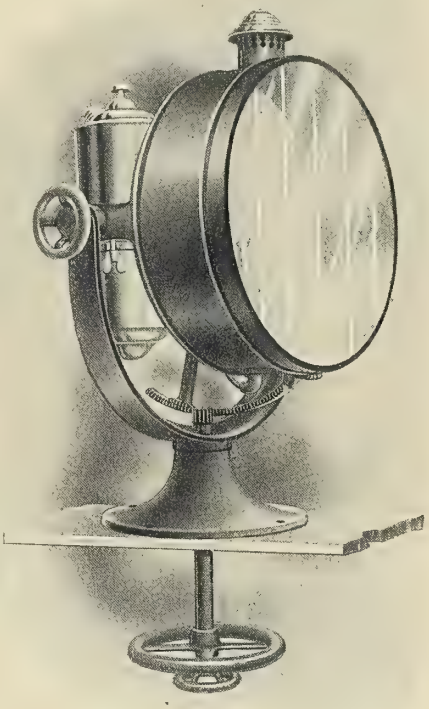


BECKER-BRAINARD GEAR CUTTER.

6 3-4 in. The machine is also made in larger sizes, 24 in. and 36 in. Additional details can be had from the manufacturers, the Becker-Brainard Milling Machine Co., Hyde Park, Mass.

Acetylene Search Light.

In boats which are not fitted with electric lighting equipment an acetylene search light is a very effective substitute for the electric projector. The light illus-



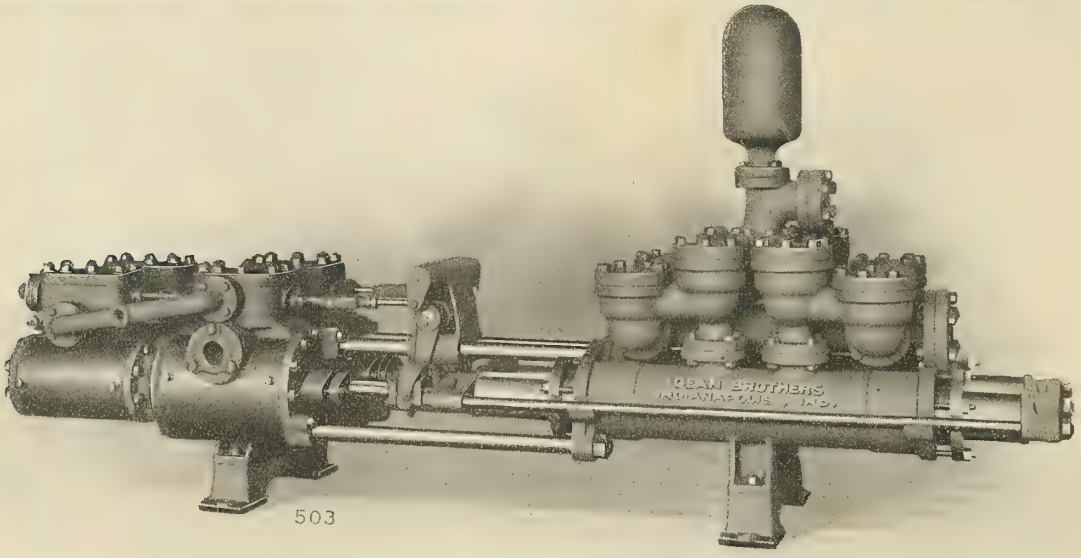
ACETYLENE SEARCH LIGHT.

trated has been specially designed for marine uses. It is self contained and requires no separate apparatus for generating the gas. The construction is very simple, the body of the searchlight being a bowl-shaped receptacle containing the reflector. The front of this receptacle consists of a glass cover suitably hinged so as to be opened for lighting the burner. To the back of the searchlight body the gas generator is directly attached. It is made ornamental in appearance and is nickel plated. All the trimmings of the searchlight are nickeled, while the stand and body are finished in black enamel. For manipulating the light from within the pilot house there is a segment of a gear attached to the body of the searchlight, and in this a small pinion engages. This pinion is connected with a small hand wheel within the house, and imparts a rocking motion to the searchlight. Horizontal motion is imparted by means of a larger hand wheel. When it is desired to direct the light from the deck the handling gear is dispensed with and the operator simply moves the searchlight itself in the required direction. This searchlight is manufactured by the Carlisle & Finch Co., 231 East Clinton avenue, Cincinnati, Ohio.

Compound Duplex Plunger Pump.

The pump here shown is especially designed for supplying marine boilers. It is very heavy, carefully made and constructed of the best materials. It is of the duplex type with tandem compound steam cylinders. The

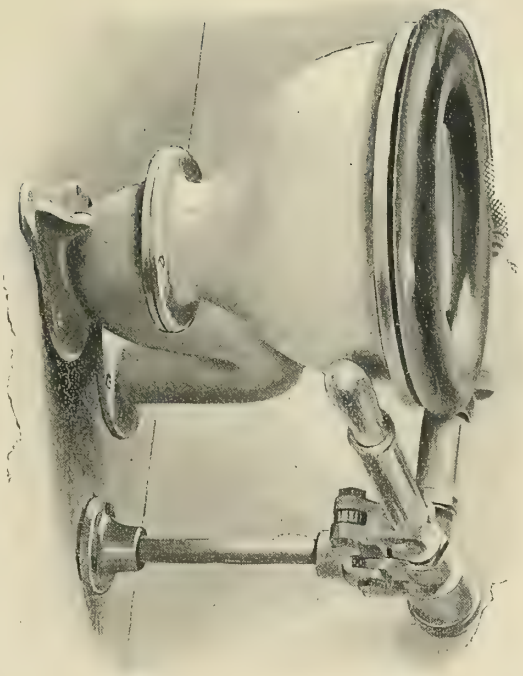
pump is of the double plunger "trombone" pattern, intended for working against high pressure for long periods without repairs. The plungers are of hard bronze and the stuffing boxes bronze lined. Plunger pumps especially under high pressure, have certain advantages over piston pumps. They are very durable, the only wearing part of the pump being the packing of the stuffing boxes. No leak can occur without its being seen, and it is easily stopped by setting the packing. The piston rods do not enter the pump cylinder, and are therefore not exposed to the action of the water. The valves are arranged in "pots" so as to be readily accessible by taking off the cover. The valve seats are of bronze, screwed into the casting against a shoulder in such a manner that they cannot work loose. The valves, valve seats and valve stems are of bronze. The piston rods between the high and low pressure cylinders are fitted with automatic adjustable metallic packing that will always remain tight. These pumps are manufactured by Dean Bros., Steam Pump Works, Indianapolis, Ind.



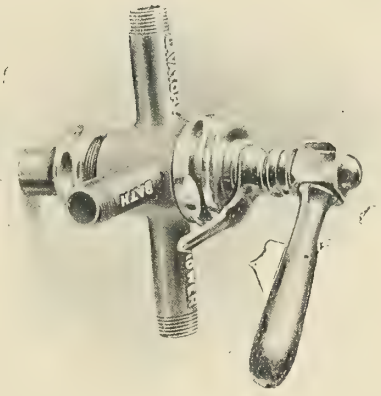
DEAN COMPOUND DUPLEX PLUNGER MARINE PUMP.

Modern Marine Plumbing.

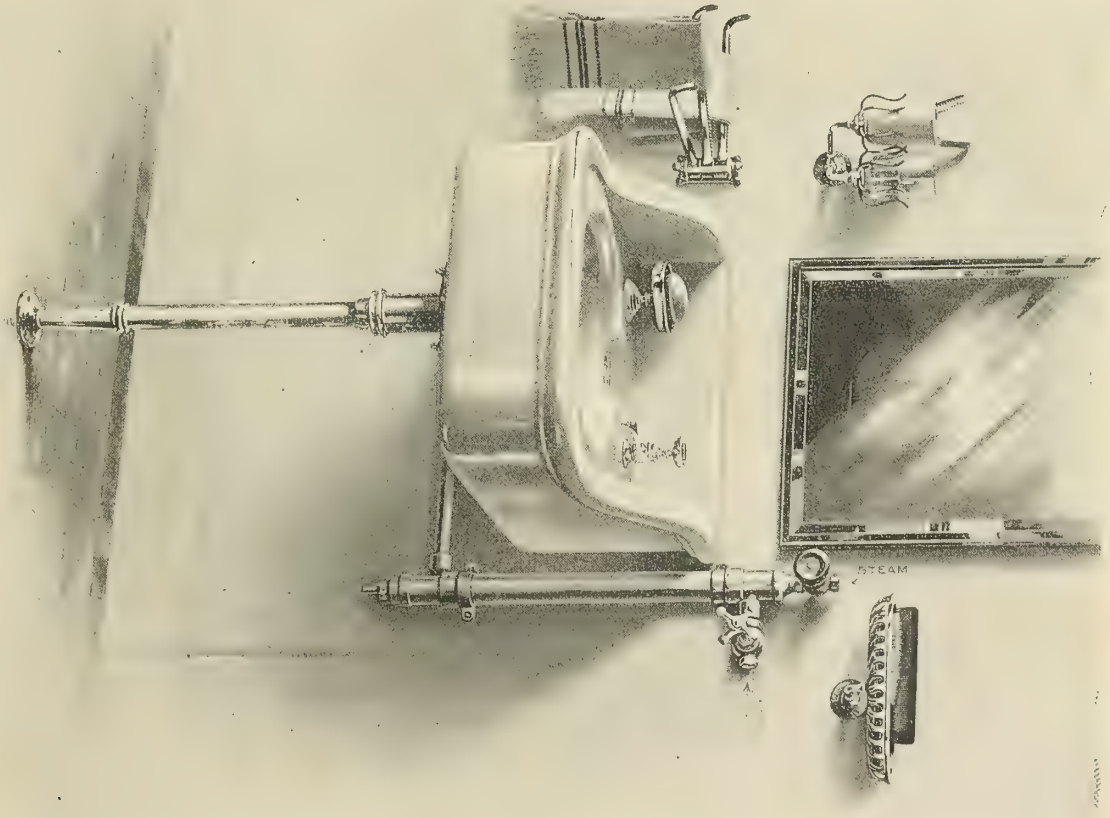
In vessel equipment there has, probably, been greater advancement made in the construction of sanitary appliances in recent years than in any other ship fittings. Special attention has been given to this subject by the J. L. Mott Iron Works, and as a result the artistic productions of their designers have been extensively installed on war vessels, transports, liners, yachts, and harbor vessels of every description. Experience has taught that enameled iron or porcelain baths or lavatories will not remain in good condition for any length of time on shipboard, and thus it has come about that the material styled "imperial porcelain" is used almost exclusively by this company for the better class of fittings. On an adjoining page we show some recent designs put to the test of practical service. The "Imperial Porcelain Lavatory" is one of the most popular for ship use at the present time. It is compact, measuring only 20 in. by 20 in., and is exceedingly strong and durable. It is made with a projecting rim on the inside to prevent splashing, and has nickel plated brass leg, spout, soap cup, plug, coupling, stopper and chain, and patent economic heater. This heater has steam and water connections, so that the supply can be made hot or cold as desired by a simple manipulation of the cocks. It will be noticed, too, that this lavatory is moulded in one piece, so that the objectionable joint between the back and the slab is got rid of. The attention to detail is shown in the wall fittings, which are also of improved form. The towel rack has serrated arms, so that the towels will not slip with the motion of the ship, and also has springs to hold the arms in position wherever they are placed. The glass holders are fitted with springs, thus preventing rattling at sea. The water closet shown is known as the "Wilmington," and represents a rougher class of fitting, for the use of seamen or firemen. It is made of enameled iron, with hard wood seat and with brass non-hammering, slow closing valve. It is very strongly built, and is so simple that it cannot be easily damaged or get out of order. Such closet is sent out with a brace for securing it to the deck and a connection to the hopper. This closet was designed to replace the usual troughs, and it has been fitted in the U. S. gunboats *Nashville, Wilmington,* and *Helena,* and also on the U. S. battleships *Kearsarge* and *Kentucky.* In the engraving of the "Three Way Valve" there is shown a most convenient connection for marine plumbing. By means of this valve in connection with a heater, hot or cold water is delivered to the bath, lavatory, or shower, as required. It is so constructed that while directing the water to any one fixture, it cannot be turned so as to shut the water off entirely. This is an important feature, as it prevents the water in the heater from being so shut in that it cannot expand. In addition to the fixtures here shown, an immense variety is carried in stock by the manufacturers, The J. L. Mott Iron Works, 84-90 Beekman street, New York.



Crew's Water Closet.



Three Way Valve.



Imperial Porcelain Cabin Toilet Set.

TYPES OF MODERN FITTINGS IN SHIPS' PLUMBING MANUFACTURED BY THE J. L. MOTT IRON WORKS OF NEW YORK.

MARINE ENGINEERING

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Notice to Advertisers.

Copy for changes in advertisements must be in our hands not later than the 20th of the month to insure changes being made in the issue of the month following, and not later than the 15th of the month if corrected proof is to be submitted.

IN older days of the publishing business the Circulation Fakir was relied upon chiefly to draw public attention to his employer's publication. More wholesome methods have made this office obsolete, though in some unprogressive cases traces of his functions remain. In present days publications which appeal to popular taste have sought to draw attention to themselves by the employment of the Inventor, who is an up-to-date substitute for the Circulation Fakir. This type of Inventor is not content to produce some article or process of real value, secure patent rights, and then endeavor to benefit mankind, and incidentally enrich himself, in a business like, practical way. On the contrary he is usually a cerebrose individual, with a mission; a bombastical genius who has illumed unknown fields of imaginative science with his intellectual searchlight and is willing to permit the gaping world of ignorance or complaisance to peep in and wonder, some credulous editor drawing the curtain. The most brilliant example of the handiwork of such an individual, which has come to our notice recently, is exhibited in the June edition of *The Century Magazine*, published in New York, in the shape of an article—a "preachment" would sound more literary like—entitled "The Problem of Increasing Human Energy," by one Nikola Tesla. This dazzling contribution to modern unscientific research reads like nothing so much as an essay on Christian Science, so profound is it in the ambiguous nothingness whereby it leads through the intricacies of incoherency unto the climax of absolute assininity. This climax is reached for us in the following statement excerpted from page 198 of the June *Century:*

> * * * Steamers and trains are still being propelled by direct application of steam power to shafts or axles. A much greater percentage of the heat-energy of the fuel could be transformed in motive energy by using, in place of the adopted marine engines and locomotives, dynamos driven by specially designed high-pressure steam- or gas-engines, and by utilizing the electricity generated for the propulsion. A gain of from fifty to one hundred per cent in the effective energy derived from the coal could be secured in this manner.

It is no doubt beyond the comprehension of the literary gentlemen who publish *The Century Magazine* to understand that progress in marine propulsion is slow, very slow, and that there is nothing in the entire domain of scientific research that promises any hope of being able to transform a much greater percentage of the heat energy of fuel into motive energy by employing dynamos driven by specially designed high pressure steam or gas engines. It is to be expected, however, that as those responsible for the statements made in what has been considered one of the foremost literary magazines of the country, they should appreciate their lack of expert knowledge and by procuring suitable editorial assistance safe-guard their readers, the reputation of the magazine, and their own sense of right. Under the circumstances we most unqualifiedly pronounce the statement here reproduced from *The Century Magazine*, regarding marine propulsion, as a crude and ignorant fake. It is a question whether such silly stuff deserves any serious recognition, but for the benefit of those who might invest money to further some such project as the application of electric generating sets to the direct propulsion of vessels, we have invited one of the foremost living authorities in marine construction to reply. This reply, written by William F. Durand, of Cornell University, will be found elsewhere in this issue. It is simply a plain statement of scientific truths and the possibilities of the art of vessel construction divested of all mathematical complications, so that even the

untechnical reader can readily comprehend it. We commend it to the serious attention of those in whom the wish is father to the thought, that in some way, by the genius of some poor, miserable human atom, the majestic forces of nature will be cheated of their indivisible and inalienable rights.

BEFORE the adjournment of the Fifty-sixth Congress provision was made in the Naval Appropriation bill for the purchase of armor plate. This clause was in the nature of a compromise between those who take a rational view of the armor plate question and the advocates of a Government armor plate mill. By its terms the Secretary of the Navy is authorized to contract for armor plate for all the armored vessels authorized by Congress, some of which are now under construction, provided that, in his judgment, the price asked by manufacturers is a reasonable one. If, on the contrary, he believes that the price quoted by bidders is excessive, he is directed to establish a Government armor plate mill, for which purpose the sum of $4,000,000 is made available. Following upon the passage of the appropriation bill the Navy Department has issued a circular calling for bids on 31,000 tons of Krupp armor, 3,600 tons of Harveyized armor and 1,150 tons of nickel steel armor. This is for the purpose of completing those armored vessels building or projected, for the protection of which no provision had hitherto been made. These vessels are as follows: Battleships U. S. S. *Maine*, U. S. S. *Missouri*, U. S. S. *Ohio*, U. S. S. *Pennsylvania*, U. S. S. *New Jersey*, U. S. S. *Georgia*, U. S. S. *Virginia* and U. S. S. *Rhode Island*; armored cruisers, U. S. S. *California*, U. S. S. *Nebraska*, U. S. S. *West Virginia*, U. S. S. *Maryland*, U. S. S. *Colorado* and U. S. S. *South Dakota*; protected cruisers, U. S. S. *St. Louis*, U. S. S. *Milwaukee* and U. S. S. *Charleston*. The last named is to replace the warship of the same name lost off the north coast of Luzon, P. I. Only three of these vessels are now under construction, the battleships *Maine*, *Missouri* and *Ohio*. Of the others, those authorized by the Naval Appropriation bill of March, 1899, could not be contracted for owing to a clause in the bill which prevented the letting of contracts for the vessels until the armor had been provided for them. Thus Congress effectually delayed the construction of these ships a twelvemonth. We wonder is it any consolation to those who thus blocked our naval progress or preparedness to read the news of impending troubles in China, which may eventually make a greater call on our naval resources than the Spanish war did. However, at the eleventh hour, as it were, Congress seems to have realized the undignified, even childish, position it had taken on this question, and not only gave the necessary authorization for the purchase of armor, but added to the list of vessels provided by the previous Congress, and agreed upon an expenditure of about $60,000,000 in all on the navy. Though the present shipbuilding programme is a large one, it is not so, relatively, when the advances of foreign nations in naval construction and the rapid growth of our foreign trade are considered. There is cause for thankfulness, however, that the armor plate bogie has been frightened off, and that a fresh start has been made in our naval construction. There is, of course, a great weight of responsibility now resting upon Secretary of the Navy John D. Long to decide whether or not the armor plate contracts will be given to private bidders. The placing of contracts which call for the expenditure of several million dollars of the people's money would, under any circumstances, be a great responsibility, but in this instance the Secretary is invested with almost judicial powers and responsibilities. He must look at the question from many points of view. One point that should be always kept in sight is that the price paid private contractors is for accepted armor, armor that in every respect conforms to specifications. All defective plates, all wastes, all failures in manufacturing processes are at the expense of the contractor. The quality of contractors' armor is real, it has been proven by actual test, while the quality of plate produced in a Government mill is speculative or imaginative. As a common sense business proposition, is it likely that the Government could secure the services of qualified experts in its mill, where work would be carried on only intermittently, as against private employers, whose works are continuously in operation, not, perhaps, in the production of armor plate, but in many other metallurgical processes? There is also the all-important question of date of deliveries, for until the Government works could turn out satisfactory plates all additions to our real fighting squadrons would be at a standstill, while in the case of private contractors immediate deliveries are possible.

Loss of Cunard S.S. "Carinthia."

We here present a photograph of the fine freight steamer *Carinthia*, late of the Boston service of the Cunard line, which went ashore at Point Gravois, Haiti, as reported in our last issue. Latest advices from there are to the effect that the vessel is in a bad way and the chances of saving her are very remote. Several of her crew, officers and men, recently passed through New York on their way home to Liverpool from the wrecked vessel. The mishap occurred while the *Carinthia* was on her way from New Orleans to Cape Town with a consignment of mules for the British Army in South Africa. As the photograph shows, the *Carinthia* had a very pleasing appearance, better in fact than that presented by many passenger boats. She was an exceptionally strong vessel, too, having been designed in accordance with Lloyds 100 A1 class with extra strengthening at the bilge and topsides. She had a good record for economy, having a gross tonnage of about 5,600 tons and dead weight capacity of 7,500 tons, and averaging a consumption of 63 tons of coal per day in regular service.

EDUCATIONAL DEPARTMENT.

HELPS FOR CANDIDATES FOR MARINE ENGINEERS' LICENSES—FIREROOM—II.

BY DR. WILLIAM FREDERICK DURAND.

ROUTINE AND MANAGEMENT.

Water-tending. The care of the water is the most important and responsible of the duties in the fire-room. The ideal is to keep the water regularly flowing inward through the check-valves at about the same rate as it is flowing outward as steam through the steam pipe. This requires constant watch and adjustment of the valves, closing down where it is entering too rapidly and opening up where it is entering too slowly. Instead of this method it is often the custom to put the feed on strong first to one boiler and then another, in order, according to the firing, feeding the boiler up when the fire is at its best, and shutting down when it is freshly coaled. The steady and uniform feed is, however, better because it approaches more nearly to a uniform condition of the boiler, especially on the water side.

BROADSIDE VIEW OF THE CUNARDER FREIGHT S. S. CARINTHIA (BOSTON ROUTE) WRECKED AT POINT GRAVOIS, HAITI.

While bound West on May 22, the American liner *New York* broke her port outboard shaft, and the A frame being unable to carry the weight of the tail shaft and propeller broke and both were lost. The mishap occurred without any warning, and the automatic device with which the engines are fitted instantly brought the gear to mid position and prevented a probable repetition of the mishap to the *Paris* some years ago. Steam was crowded on the starboard engine and the remainder of the voyage was made at about 15 knots rate, the liner reaching New York, May 28. It was first intended to send her across for repairs, as the spares were at Southampton, but a careful examination of the starboard engine revealed symptoms of weakness in the crank shaft and the vessel was sent to Newport News for an overhaul.

The position of the water is determined, of course, from the water gauge and cocks. It is necessary, of course, that the gauge and its connections be clear of any obstruction in order that the height of the water may be properly indicated. To make sure that everything is clear the gauge glass and connections are blown through by the "double shut off" method as follows. In Fig. 1 G represents the glass, A the trip cock, B and C the cocks connecting to the stand, and D and E those connecting the stand to the boiler. First, B and E are closed, and A is opened. If steam blows through it shows that $A\,G\,C\,D$ are clear. Second, C and D are closed and A is opened. If water blows through it shows that $A\,B\,E$ are clear. The action of the water in the glass will usually show to an experienced eye whether or not the connections are clear. If the water

is lively and follows the rolling of the ship it is a good indication that the passages are clear. Otherwise it indicates that an obstruction exists which must be sought out without delay. In the meantime the water cocks are relied upon, and in fact many experienced water tenders prefer the indications of the cocks to those of the glass, while they should in all cases be freely used as a check on the glass. To those without experience, however, the glass is less apt to be misleading. The indications of the water cocks are sometimes difficult to interpret, because frequently it is not easy to tell whether water or steam is blowing off. With high pressure steam especially, a jet of water issuing at a temperature of 350 deg. to 400 deg. is instantly surrounded with a shell vapor formed by the vaporization of part of the jet. Furthermore, if the water in the boiler is in active ebullition near to the surface so that the jet would be drawn from a mixture of steam and water, then on issuing it becomes practically a jet of moist steam. On the other hand if the water is well below the cock so that the jet would be drawn from steam alone or from

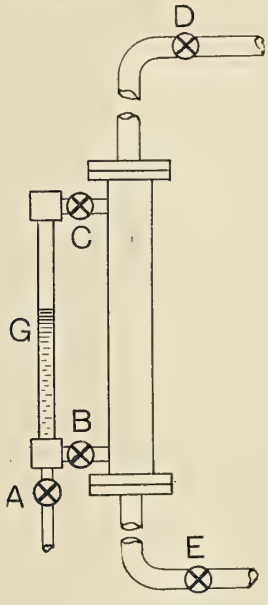


FIG. 1.

moist steam, then on issuing it will become dry and usually super-heated. It is also a fact, especially with water-tube boilers, that due to a kind of lifting action, a cock will often discharge moist steam or a mixture of water and steam, even if the water level is somewhat below the mouth of the cock. It is hence readily seen that the indications from the cocks must be interpreted with judgment, and that some experience is necessary in order to always draw correct conclusions from them. It is often difficult to distinguish between an empty glass and one entirely full. In order to make sure close the cock *B*, Fig. 1, and slightly open *A*. If the gauge is full of water the surface will gradually descend, first coming into view in the top of the glass and then passing out of view at the bottom. If then *A* is closed and *B* is slightly opened, the water will rise again in the glass and pass out of view at the top.

Blowing Off. Blowing off boilers to reduce the concentration or density of the water is now rare in good practice. Instead of reducing density by introducing sea-water for feed make up, evaporators are installed for providing fresh water make up, or for short runs additional fresh water is often carried in spare tanks provided for the purpose.

In modern practice the purpose of blowing off is (1) to get rid of mud or slush in the bottom of the boiler or in the special mud drums of a water-tube boiler, and (2) to get rid of oil and scum at and near the surface of the water. For the former a button blow or special mud cock is required, while for the latter the surface blow is used. In ordinary experience on deep sea voyages where evaporators or other fresh water make up is provided, the use of the surface blow is all that is needed to keep the water in good working condition. It must not be forgotten that the use of the blow-off means a direct loss of heat, and hence it should be used with discretion, and no more frequently than is needed for the purpose in view. An idea of the condition of the water in the boiler near the surface may be obtained by drawing off a little water from a cock fitted into the surface blow pipe, or from a gauge cock fitted directly to the boiler. The water being allowed to cool and settle, is then poured into a glass jar, when its condition is readily noted, and the need of using the blow determined.

It may be well to speak at this point of the proper method of testing, from the outside, the correct position of a plug cock handle for "closed" and for "open." Instances have been known where there was no mark on the head of the plug, and the handle becoming bent or being wrongly placed, the cock was left shut when it was supposed to be open, or open when supposed to be shut, with the possibility of most serious consequences, especially in the latter case.

A careful examination of the cock, aided if need be by placing the ear to the chamber, will suffice to tell whether or not the cock is open and water or steam passing through. Then the cock being open let it be turned in one direction until it is just closed, and then back in the other direction until it is closed again. Half way between these two positions it will be wide open, and at right angles to the latter position it will be full shut.

Taking the Saturation of Testing the Density of the Water.—The density of the water is determined by the use of a hydrometer or salinometer as it is often termed. Under modern conditions where evaporators provide fresh water make up, the density rises but slowly, and it is usually only necessary to observe its value once or twice a day. It is usually not allowed to rise above two or two and one-half.

Disposal of Ashes.—For the disposal of ashes two chief means are in use. According to the older method they are sent up and disposed of through an ash chute leading overboard and down the side of the ship to the water, and this method is still extensively used in large and deep ships. In the more modern system they are disposed of from the fire-room direct by means of an ash ejector. In either system it is usually sufficient to dispose of the ashes once in a watch, and they are collected, wet down and either hoisted in buckets or shoveled direct into the ash hopper usually between 6 and 7 bells.

Cleaning of Fires.—The routine working of fires spoken of above will suffice to keep them in fairly good

condition for several hours, provided the coal is of fairly good quality. It usually becomes necessary, however, to give to each fire from time to time a more thorough cleaning than is possible in the manner previously referred to. To this end the fire should be taken when partly burned down, but not too far lest there be nothing left after cleaning on which to build up again. One side may be cleaned first, working the good coal over to the other side, separating out the clinker and ashes, and hauling out the latter. Then similarly with the other side, working the good coal over to the side first cleaned and pulling out the clinker and ash. The live coal is then spread over the grates fired lightly, and so brought up again into regular condition. In some cases there is so little left after a thorough cleaning that live coal must be borrowed from another furnace to save the fire. Only judgment and experience can determine the best point at which to clean a fire so as to insure the minimum loss of heat, and at the same time have enough coal left to nicely build on again. Some engineers prefer to burn the fire almost completely down to the ashes and clinker, and then pull the entire contents of the grate out and start afresh. This method, however, chills the furnace and more seriously interferes with the operation of the boiler, and is not to be recommended. It must of course not be forgotten that heat is lost with the clinker and ashes withdrawn, and the general operation should be so conducted as to keep this loss down to the minimum possible.

Under usual conditions the fires will need cleaning in this way at intervals of from 12 to 16 hours, or at least once a day.

International Steamship Co.—There is now in process of organization on the Great Lakes a new steamship company, whose operations will be closely watched by maritime interests, both lake and coast. This company is styled the International Steamship Co. In anticipation of its organization a contract was made in April last with the American Shipbuilding Co. for the construction of six vessels as a nucleus of this line. These vessels include three steamers and three tow barges. Two of the steamers and two tow barges will be in commission by Oct. 1, next, and will be operated for the remainder of the season in the Duluth-Montreal trade. Just before the close of lake navigation they will be sent to the Atlantic Coast to engage in the coastwise or deep water trade, according as business demands. The vessels are all of the full Welland Canal size, of these dimensions: Length, 256 ft.; beam, 42 ft.; depth moulded, 26 ft.; maximum load draft, 18 ft. On the Welland Canal draft of 14 ft., the steamers will carry 2,100 tons, and the barges 2,400 tons, and at the 18 ft. draft the figures are: Steamers, 3,600 tons; barges, 3,900 tons. The steamers will be equipped with quadruple expansion engines and independent auxiliaries and B. & W. water tube boilers. The maximum horse power will be 1,500 I. H. P. The hulls of these vessels will be constructed on the usual transverse system with the main deck beams all in place but no laid deck. They will have water bottoms, 4 ft. deep, and in the steamers the machinery will be at the extreme after end, in the usual lake style. Screen bulkheads through the cargo spaces will be made water-tight, and arrangements will be made for carrying water ballast in the cargo compartments when the vessels are running light.

ENGINEERS' DICTIONARY.—XXIX.

Moist Steam—Steam in which there is suspended a certain proportion of water in the form of fine mist. The steam given by the average boiler is slightly moist, the proportion of water very commonly running up to 2 or 3 per cent., and even more in some cases. The term *quality* of steam has reference to the proportion of water. Thus steam with a quality of 2 1-2 per cent means moist steam containing 2 1-2 per cent of water.

Monkey-Tail-Valve—A name sometimes given to a valve which admits high pressure steam into the low-pressure cylinder of a compound, or the intermediate cylinder of a triple or multiple expansion engine. The purpose of such admission is to aid in starting the engine when the high pressure cylinder is on the center. In modern times they are more commonly known as passover or starting valves.

Mud-Box or Drum—A box or drum frequently fitted on water-tube boilers, and usually connected to or forming a part of the lower or feed drum. Its purpose is to form a place in which mud and scale may collect, and from which it may be removed by blowing or by removal from time to time through an appropriate hand-hole or like opening. See also under *Boiler*.

Natural Draft or *Funnel Draft*—Draft which is due simply to the funnel, and unassisted by fans or jets or other means for forcing or mechanically producing a draft.

Nominal Horse Power—A term used in the earlier days of marine engineering to indicate approximately the power which might be expected from a given engine. It was based upon an assumed set of conditions of operation, and was found by an arbitrary rule involving these conditions and certain dimensions of the engine. Watt used the following rule for nominal horse-power:

> Power=area of piston multiplied by 896 multiplied by $\sqrt[3]{\text{stroke}}$, and divided by 33,000.

The Admiralty rule was:

> Power=area of piston multiplied by speed of piston multiplied by 7, and divided by 33,000.

While a later mercantile rule was:

> Power=(diam. of piston in inches)^2 divided by 30.

The term is still used abroad by marine engine builders, to some extent, for commercial purposes.

Non-Return Valve—A general name for a class of valves opening freely and allowing a flow of liquid vapor or gas in one direction, but closing automatically and preventing any return flow in the opposite direction. Feed check valves, pump inflow and delivery valves, etc., are all examples of non-return valves.

Oil Groove.—A groove or small channel cut in the surface of a bearing, and intended to furnish a way whereby the oil may become distributed from the point of supply to the different parts of the bearing as needed.

Oil Hole.—A small hole or channel leading from some convenient external point to the surface of a bearing, and through which oil may be introduced as required.

TECHNICAL PUBLICATIONS.

A Manual of Naval Architecture. By Sir W. H. White, K. C. B., Director of Naval Construction, Admiralty, London. Fifth Edition, 1900. New York, D. Van Nostrand Co. Size 6 by 9 1-2 in. Pages 731. With 176 figures. Cloth, $9.00.

This edition of *White's Naval Architecture* seems to be the same as that of 1894, with the addition of two pages of matter distributed between pp. 166 and 176, and relating to the influence of bilge keels on rolling. So far, therefore, as a review of new matter is concerned, it would be only necessary to refer to these additions to the chapter treating of the rolling of ships. This book, however, has justly attained to so high a place in the estimation of the marine public, that it may not be without interest to examine it briefly as a whole, and as it now stands.

In the author's preface it is stated that the book has from the first been chiefly written for the use of officers of the naval and mercantile marines, and as an introduction for students of naval architecture to more formal and mathematical treatises. It was also expected to serve as a book of general reference for naval architects, ship-builders and marine engineers. The plan thus laid down by the author has been consistently followed from the first, and the work as a whole is therefore descriptive and general rather than formal and complete in any one branch of the subject. The purpose of the author has apparently been to give an intelligent idea of the nature of the more important questions and topics which come up for consideration in connection with the design, construction and propulsion of a ship, but without going into the detail of methods for actual or quantitative computation, except incidentally or for roughly approximate purposes. Thus, while *displacement, tons per inch*, and like geometrical properties are described and illustrated, no methods are given for their actual computation. Similarly with the subject of *stability*, a general and elementary exposition is given of the theory with a large amount of illustrative matter, but without reference to detailed methods for its computation under any given set of conditions. Again, in the discussion of the screw propeller, the theory is developed in some detail, various experimental investigations are described, and a large amount of general information is given in a very interesting and instructive manner, but without rules or methods for actually designing or proportioning a propeller to meet the requirements of a given case. Again, the theoretical development is throughout quite abridged, and the student will note the omission of many points presumably not considered necessary for the purposes of the author. These points are referred to not in criticism, but simply to show from what standpoint the author has carried the work through.

As a whole the book is divided into eighteen chapters, and due to the limitation of space only a passing reference can be made to some of the more important features of these sub-divisions of the work.

In Chapter I the general subjects of displacement, buoyancy, and the fundamental theory of a floating body are taken up. Loss of buoyancy by the flooding of compartments and sub-division by bulkheads are also considered, and an interesting historical summary is given of the subject of load-line and freeboard legislation and rules.

In Chapter II the subject of tonnage is treated quite fully, both historically and with reference to the various points involved in the subject as determined by the present existing laws and regulations. Chapter III is devoted to the subject of the statical stability of ships, as referred to in the foregoing introductory remarks.

Chapter IV is devoted to the subject of the oscillations of ships in still water. A portion of the elementary theory is given in a general or descriptive manner, while the subject of the influence of bilge keels is considered in some detail. It will be remembered that experiments on British battle-ships of the *Royal Sovereign* class showed that the effect of bilge keels was enormously greater than had been expected or estimated by the use of the formulæ and co-efficients usually employed for such purposes, such co-efficients being derived from experiments on the resistance to the motion of planes through water in a direction at right angles to the surface. The new matter added in this chapter has chiefly reference to these battle-ship experiments, both on the actual ships and on models, and to the possible basis of an explanation of the discrepancy. In regard to the latter point special emphasis is laid on the wave-making action of a bilge keel, and the consequent increase in the resistance to its motion, as possibly accounting in large measure for its increased efficiency. On this point reference may be made to a paper recently read before the Institution of Naval Architects by G. H. Bryan, F.R.S., on this same point, in which the added resistance is considered as due to the development of discontinuous motions in the water as the keel swings through it to and fro. While the author seems to have been disposed to bring this particular chapter down to actual date, he has apparently overlooked the interesting and important experiments made in 1895 in the Italian experimental tank at Spezia on a model of the *Sardegna*, and which showed results of a character similar to those in the English experiments quoted.

Chapters V, VI and VII are devoted to the subjects of deep sea waves, the rolling of a ship among waves, and methods of observing the rolling and pitching of ships. These chapters are chiefly descriptive, though here and there the elementary results of theory are given. They present the subject in an interesting and instructive manner, and are especially intended to awaken in the sea-going officer an intelligent interest in the waves of the sea, the motions of his ship among them, and the methods of making and recording observations and records of such motions.

In Chapters VIII and IX are discussed the strains experienced by ships, their structural arrangements, and the general question of strength. The cause of sagging and hogging stresses is clearly explained, and a general description is given of the method of computing the moment of inertia of the structural section. For the latter, illustrative computations are given, though it may be regretted that they are based on a diagram of the equivalent girder section rather than directly on the structural section itself. The diagram of the equivalent girder may be of value for purposes of illustration or instruction, but it is of no advantage for the actual com-

putation, which in all usual cases may be better made direct from the structural section itself.

In Chapter X the subject of shipbuilding is taken up in a brief way, the purpose being chiefly to show the distribution of the various members in the structure of a ship, and the manner in which they take their part in the formation of the ship as a whole. Unnecessary prominence is perhaps given to iron as a material for ship-building, and to comparisons showing the advantages of steel over iron. At this day we do not need such comparisons, though they may perhaps have been more appropriate in 1894.

In Chapter XI the subject of the resistance of ships is treated from the descriptive and general standpoint. The more important theories and their consequences are stated and discussed, and their bearing on the general subject of resistance is brought out. Especial prominence is of course given to the experimental work of the late Wm. Froude and of his son, R. E. Froude. The law of comparison is explained and its use in the estimation of resistance is illustrated. Air resistance and the modification of resistance due to waves are also briefly considered.

In Chapter XII propulsion by sails is considered, the accepted theory as based on the laws of wind pressure being discussed, and various practical and empirical results relating to the location of the sails, amount of sail area, etc., are given.

Chapter XIII deals with the general question of steam propulsion, propulsive co-efficients, and the interaction between ship and propeller. Some reference is also made to the subdivision of the work developed in the cylinders among the various items, and the bearing of these various parts on the general problem of propulsive efficiency is considered.

In Chapter XIV the author considers recent progress in marine engineering and its influence upon steamship design. An interesting and comprehensive summary is given of the progress due to forced draft, water-tube boilers, the use of steam of continually advancing pressures in multiple expansion engines, increase in piston speed, reduction of weights by improved design, increase in engine efficiency, etc., etc. This chapter is naturally of an accessory or supplementary nature, so far as the main purpose of the book is concerned, the object being simply to give a brief but comprehensive view of the relation of the art of marine engineering to the general problem of steamship design. While well up to date for 1894 this chapter is, as noted below, somewhat behind the times for 1900.

Chapter XV deals with the subject of marine propellers, and contains a general and descriptive discussion of the paddle-wheel and screw propeller with reference to the attempts to use water-jets on the *Waterwitch* and *Hydromotor*. A brief exposition is given of the theory of the screw propeller from the Rankine standpoint, that is, by a consideration of the mass of water acted on and the acceleration impressed upon it. The theory developed is understood of course to apply only to certain ideal conditions, and a reference is made to the general character of the influences which modify these simple ideals. There is perhaps a danger that sufficient prominence has not been given to the latter points, and that the reader not already well grounded in this part of the subject might gain the impression that the simple theory as given is reasonably complete and ample for practical or working purposes. As a matter of fact, it is of almost no use whatever from the direct designing standpoint, the actual design of propellers being entirely based on empirical formulæ derived either from actual experience or from experimental results on model propellers, rather than on abstract theory. These points are indeed considered later in the chapter, and extended reference is made to the work of R. E. Froude and others in the experimental field, and to the use of their results as a basis of screw propeller design, though the actual methods are not given.

In Chapter XVII the subject of estimates for the horse power and speed of ships is considered, with some general notice of steamship efficiency. The two "admiralty" co-efficients (midship section and displacement) are considered, and their use is explained. Rankine's augmented surface method is also brought forward, simply, it may be supposed, as a matter of historical interest, and because the author hesitated to omit from his pages a method backed by so notable a name. The method by the use of the so-called extended law of comparison is also briefly considered. A much fuller reference to this method and to its relation to the use of the admiralty co-efficients might with advantage have been included.

In Chapter XVIII and the last the author deals with the steering of ships. This subject is naturally one in which both the designer and the sea-going officer are keenly interested. The elementary theory of the rudder is given, together with an interesting historical summary referring to various forms and varieties of rudder and steering gear which have been proposed from time to time. The interaction between the propeller and the rudder and the influence of the former on steering are also considered. Reference is also made to the path followed by a ship in turning, and to the methods for determining this path by practical observations. As a whole this chapter covers a wide range of most interesting and valuable matter presented in a clear and instructive style, and apparently brought well down to the date of publication in this form.

The chief disappointment with the present edition of the work as a whole is that it is not brought down to 1900 rather than 1894. The demands upon the time of the distinguished author are of course understood, but it is to be greatly regretted that having such exceptional opportunities for obtaining the most accurate information upon all subjects in this field, it has not seemed possible to introduce the many important and valuable results which have been brought forward during the past six or seven years.

Thus, during that time the magnificent experimental tank at Washington and its equipment have been completed, and work has been under way for the past year, while it is understood that the equipment of the tank at Cornell University is also well under way, and that work of research character will be soon commenced. In the chapter on steamship efficiency, the influence of modern full powered liners is inadequately referred to, as well as the exceptionally high efficiencies seemingly reached by torpedo boats and craft of the like class.

On the subject of the screw propeller also, there has been accomplished in the past six or seven years some interesting and valuable work both experimental and

theoretical, which might well have found a reference in the pages of this book. In referring to the extreme speeds of torpedo boats the statement is made on page 470 that "vessels of 180 and 200 feet have been driven at 27 knots." From 27 to 35 knots is a long step, but it has been accomplished during the past six years. In marine engineering notable advances during these years have been made in piston speeds, in steam pressure, in the use of forced draft, and especially the extension of the use of water-tube boilers. In fact, the recent wide extension of their use in naval practice which has resulted in their gaining general recognition in one form or another as the accepted type for nearly all classes of war ship design has almost wholly occurred during the past five years, and would never be suspected from the pages of this work in its present form.

The point of the whole matter is, that the fifth edition of this notable work in practically all that relates to modern and up-to-date practice is from six to ten years behind the times, the practice referred to being that of the eighties and early nineties, rather than that of the late nineties. Principles are eternal, but practice changes and grows, and so far as the entire practical side of the book is concerned it falls short of the usefulness which it might have, simply because the obsolete and out-of-date has not been pruned away and replaced by the modern and up-to-date information representing the practice of the latter part of the present decade.

In so far as the work is intended to be historical or to give brief historical summaries, of course reference to the past and its contributions to the present must be made, but for him who wishes to know the art as it actually exists to-day, practice of a more recent date than that given in this work must be at hand.

From the standpoint of 1894, however, it is a pleasure to characterize this book on the whole as a most notable and valuable contribution to the literature of the subject of marine construction, and its wide circulation and the high estimation in which it has been held are the best evidences of the manner in which it has occupied the field of usefulness held in view by the author in its preparation.

MECHANICS' AND ENGINEERS' POCKET BOOK OF TABLES, RULES AND FORMULAS. By Charles H. Haswell, M. E. Sixty-fifth edition, 130th Thousand, 1900. New York, Harper & Bros. Size 4 by 6 1-2. Pages 1,045. Leather, flexible covers, with flap and pocket, $4.00.

The first edition of this pocket book, published in 1843, was the pioneer book of its class in this country, and among such books of reference none have enjoyed so long a period of usefulness and favor with the engineering public as this. Its venerable author, the acknowledged Nestor of the profession, early saw the value of collecting together and placing in convenient form such items of information as might serve to answer the thousand and one questions arising at every turn in the engineer's practice of his profession, and the first edition, published now 57 years ago, was the result of that wise insight into the needs of the times. The steadily increasing size of the book from the first, and the growing demand which it has as steadily met, are the best proofs of the wide field of usefulness for such works, and of the manner in which this book has occupied the field.

In keeping up the successive editions of such a work of reference, however, there is a danger that it may be allowed to fall somewhat short of the march of actual progress, and that the obsolete and out-of-date may not be discarded with sufficient vigor, so that as new matter is added and time goes on, the work may become impaired by a mixture of the old with the new, the discarded and the discredited with the modern and authoritative.

From the marine standpoint the parts of the book of chief interest are those on naval architecture and marine engineering, including some reference to screw propellers. For the purpose of the naval architect or marine engineer of to-day the information given under these heads is of very small value. In large measure it is entirely out of date, no small part of the theoretical formulæ have never had any standing or practical value whatever. It is quite impossible to enter into complete details as it would require many times the space available for a review, and therefore a few illustrations must suffice.

Thus on p. 663 reference is made to the estimate of the late William Froude that about 37 to 40 per cent of the I. H. P. was effective in propelling the ship. Under modern conditions this proportion has risen to from 55 to 60 per cent and over. On p. 647 the mathematical formulæ for the resistance of different geometrical bodies moving through a liquid are inadequate and of no practical value, and have never had any standing with those having to deal with the practical side of the profession. On p. 662 the proportions relating the pitch ratio of screw propellers to the ratio between their disc area and the mid-ship section seeks to establish a relation where none of a definite character can exist. Again on pp. 886-889 the data for the most part refer to old or obsolete vessels, such, for example, as the United States cruisers *Maine, Chicago* (with old machinery), *Vesuvius,* the English torpedo boat *Sunderland,* cruiser *Archer,* the Spanish cruiser *Reina Regente,* etc., etc. On p. 896 are given various runs of sidewheel paddle steamers, the latest being of date 1870, representative boats being the *Daniel Drew, Mary Powell, R. E. Lee,* etc.

The book is accompanied by an appendix of about 100 pages, in which information on the widest variety of topics is given without reference to arrangement or order. A portion of this matter relates to marine engineering, in part data from recent experiments, as, for example, the trials of a Babcock and Wilcox boiler for the U. S. S. *Alert,* and in part matters of historical interest only, as, for example, the Emery experiments on the economy of the steam engine.

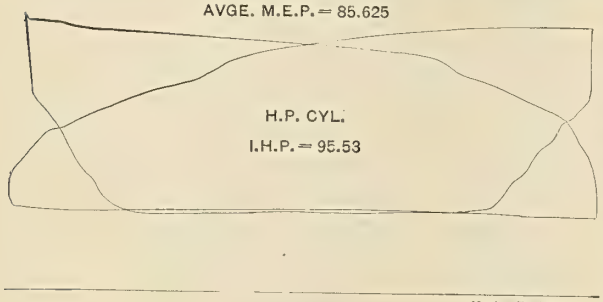
Illustrations of these points might be largely multiplied, and it is not too much to say that in so far as the value of the information given depends on its being representative of modern practice, these sections, to be of practical value to the naval architect or marine engineer, would require an entire revision, and a replacement of most of the matter given by new and up-to-date information.

Signor Marconi, who has developed a system of wireless telegraphy, is now in this country.

QUERIES AND ANSWERS.

(Communications intended for this department will not receive attention unless accompanied by the full name and address of the sender, which will be considered confidential.)

Q.—I enclose a set of triple expansion cards and would like to know where I can make improvements on the engines. The valves have link motion, and they are piston valves, one for the H. P., and one for the I. P., and two for the L. P. cylinders. They take



CARDS REDRAWN TO REDUCED SCALES.

steam through the valves and exhaust around them. I think the cards are fairly good. The engine has cylinders 9 3-8 in., 16 in. and 25 in. dia., and 16 in. stroke. When the cards were taken the engines were making 200 revolutions, with boiler pressure 170 lb. and vacuum 20 in. by the gauge. O. D.

A.—The cards you send represent fairly good triple expansion work, in fact rather better than the average. We note the H. P. card has the scale marked 140; this is an error, as it should be 100. The card is good and shows a pressure of 164 lb. at the beginning of the steam line, which is a drop from boiler pressure of only 6 lb. The pressure at the point of cut off is about 144 lb., showing a loss of 26 lb. from boiler pressure. The cause of this is due to contraction in the steam parts, and is a common failing and one that cannot be easily remedied. As the boiler pressure in the I. P. card is 175 lb. it is evident that the diagrams were not taken simultaneously, so the losses in the receivers cannot be ascertained. Probably the cards were taken one after the other, as quickly as the indicator could be shifted, and no doubt they represent the average work performed. The I. P. card looks irregular, owing to the drop in the exhaust on the crank end. This drop is due to a difference in cut off of the two ends of the L. P. cylinder. The L. P. card is good, and it also gives a good vacuum, but as already stated, the head end cuts off later than the crank end. This could be remedied very easily by giving the valve a little less lead at the head end and increasing the lead at the crank end—in other words, shift the valve very slightly. This would reduce the compression at the head end, and increase it at the crank end, and would balance the two ends of the card very nicely.

Working up the cards gives the following results: H. P.=95.53 I. H. P.; I. P.=79.19 I. H. P. and L. P.=95.20 I. H. P.—a total of about 270 I. H. P. You will notice that the I. P. card shows the least power, but the powers are all pretty well balanced as far as is practicable, and any alteration to this effect would not increase the efficiency of the engine to any extent.

If your engine has a linking in gadget on the I. P valve gear, it would be well to link it in a little, giving the I. P. a shorter cut off, and an increase of power in the I. P. cylinder would result and the H. P. would be decreased a corresponding amount, and the respective powers would even up to about 88 I. H. P. each. This would increase the pressure in the first receiver about 4 or 5 lb

Q.—Please answer the following: What would be the best thing to do if the H. P. piston ring of a compound engine would break at sea, and would it be well to try and patch it? If it could not be patched, what would be the best to do? Also would the same remedy apply in the case of the L. P. piston, and supposing there was no spare on board? E. G. W.

A.—The best thing to do with high-pressure piston rings, if they broke at sea, would be, in the case of Ramsbottom rings, to continue to use them if they were not broken in more than two or three pieces. If, however, they were broken into a greater number of pieces, holes should be bored in each end of the broken pieces and dowel pins inserted. This is the only way that a small Ramsbottom ring can be repaired. Should the rings be worn, leaving a space of 1-4 in. or more at the back of the ring, a piece of asbestos tape should be wrapped around the bottom of the groove so as to fill up this space and keep the ring from being driven into the groove, which is often the cause of these rings breaking. In the case of a deep flat ring, the simplest way to patch it would probably be to attach a plate to it on the inside, if there was room for this. Where there is not room for a patch to go on the inside of the ring, the simplest way to hold the parts together is by putting in dowel pins, as already recommended for the Ramsbottom ring.

Of course in all such cases as this, the ingenuity and ability of the engineer come into play, and he must be guided, to a great extent, by the circumstances in what he attempts to accomplish. He is also limited, to a great extent, in what he can do by the tools and material at his command. The same remedies would apply to low pressure pistons, but in the event of the low-pressure piston packing ring being entirely destroyed, a very good packing can be made of manila or hemp rope material that can always be found on shipboard and which has been used for this purpose in times past.

Q.—If a manganese bronze casting were fastened to a wooden hull by ordinary brass screws, would there be any serious corrosion of the screws due to the action of sea water and proximity to the manganese bronze?

If a tobin bronze casting had copper bolts fastening it to a wooden hull would there be any serious corrosion to either metal due to sea water or their proximity? SUBSCRIBER.

A.—There is not sufficient electro-chemical difference between manganese bronze and ordinary brass, or between tobin bronze and copper, to give rise to any noticeable corrosion in either of these cases.

The case liable to give serious trouble due to electro-chemical action is when iron or steel is in contact with copper or with a bronze very rich in copper, and both are in contact with the sea water. In such case electro-chemical action is set up and the operation goes on at the expense of the iron or steel, which thus becomes rapidly corroded.

Craft's Tables of Plate and Rivet Values for use of boiler designers, boiler makers, inspectors and engineers, to assist in designing and calculating the efficiency of boiler joints, has been issued in convenient form (folding boards) by Thomas H. Craft, 16 Kelton street, Cleveland, Ohio.